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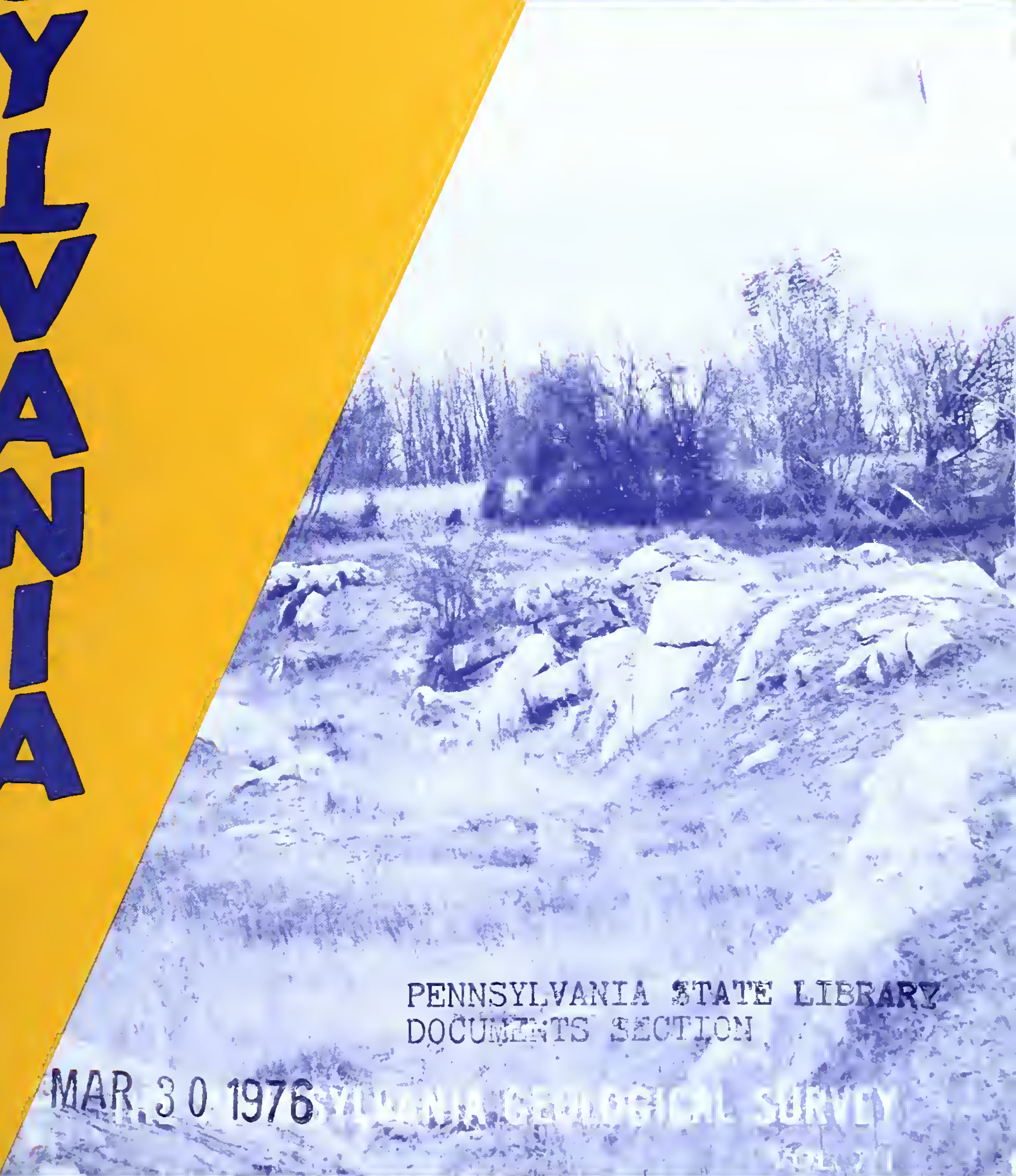
PENNSYLVANIA GEOLOGY



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PENNSYLVANIA GEOLOGICAL SURVEY

COMMONWEALTH OF PENNSYLVANIA
Milton J. Shapp, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES
Maurice K. Goddard, Secretary

TOPOGRAPHIC AND GEOLOGICAL SURVEY
Arthur A. Socolow, State Geologist

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Cover Photo: Extensive development of pinnacle weathering on Ordovician limestones at Exit 12, Interstate 81, near Carlisle. Such pinnacles are typically developed on carbonate rocks in Pennsylvania and may require special foundation procedures when building large structures. Photo courtesy of Dr. Samuel Root.

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Articles may be reprinted from this magazine if credit is given to the Topographic and Geologic Survey.

FEBRUARY 1976

FROM THE DESK
OF THE
STATE GEOLOGIST . .

OUR GEOLOGIC HERITAGE

As more and more of us are smitten by the Bicentennial "fever", it is appropriate to review the impact of geology on mankind in Pennsylvania, as well as the progress made in understanding the Commonwealth's geology.

As a founding colony with an adventuresome and industrious citizenry, the impact of geology came early in our history, long before independence was proclaimed. The fertile soil, formed from the underlying limestones of the Great Valley, called Cumberland Valley to the south, attracted an early concentration of farmers. But that same southwest-trending valley, with its low terrain, also became a passageway for the more adventurous who strove to move westward and took this easier route, rather than "fighting" the high sandstone ridges of the Appalachain Mountains. Even today, 250 years later, the Great Valley is a center of rich agriculture, community development, and transportation corridors, whereas our Appalachian ridges still are an impediment to westward transportation routes, both road and rail.

As these underlying rock formations have been responsible for our topography and for the various qualities of our soils, so too has Pennsylvania's variety of mineral resources been a controlling factor in our historical development. Limestone was used even in colonial days to make lime for the farms, and as flux-stone in the scores of small iron-making furnaces which dotted the Pennsylvania countryside amongst the hundreds of small iron mines. First using wood as a fuel, the iron-making industry soon turned to our vast resources of coal, and from the "marriage" of our limestone, iron ore, and coal evolved our great steel-making industry which today remains a cornerstone of our economy.

In the 1800's our mineral riches continued to spur our economic development, as our anthracite deposits helped fuel the industrial revolution while the 1859 discovery of the Drake Well at Titusville opened the rich Pennsylvania oil fields to our nation's needs for fuel and lubrication. The development of our natural cement-rock resources and our abundant variety of construction stone materials are further examples of the great stimulus which geology and mineral resources have had on building our Pennsylvania society. The evolution of these geologic impacts, their problems as well as their benefits will be further chronicled in this column as we progress through our Bicentennial year.

Arthur A. Socolow

REEF HUNTING IN McKEAN COUNTY CONTINUES

by
Robert G. Piotrowski

The first discovery of natural gas in Devonian "pinnacle reefs" occurred in southwestern New York (Steuben County) in 1967. The "reefs" are in the Onondaga Formation of Middle Devonian age in an area where the Onondaga regionally is less than 50 feet thick. This area of Onondaga thinning extends into north-central Pennsylvania. East and west of the "reef" area, the Onondaga thickens to over 150 feet. The "reefs" may have grown because they were located on a stable platform lying between subsiding areas.

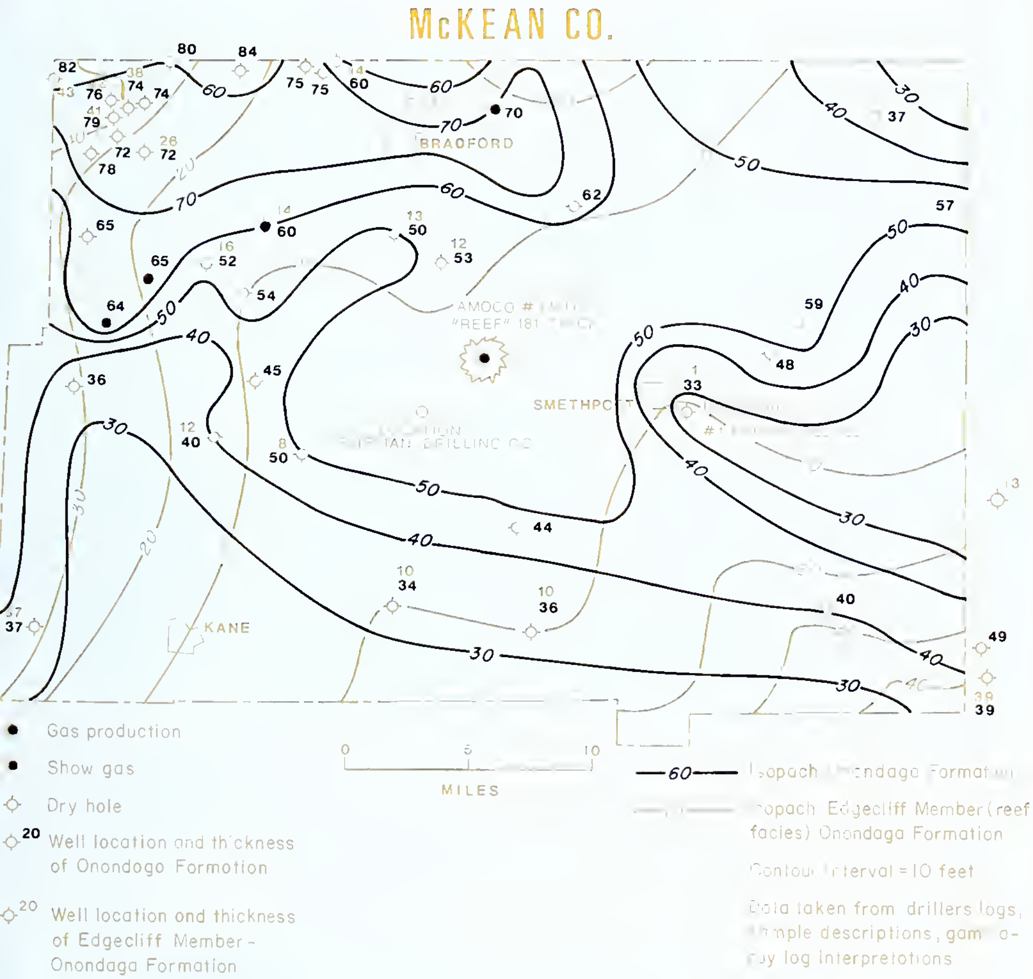
The first Onondaga "reef" discovery in Pennsylvania was made in February 1974, by Amoco Production Company with the drilling and completion of the #1 Amoco-Witco well located just southeast of the town of Cyclone in McKean County. (Fig. 1)

A Middle Devnoian Onondaga "reef" was encountered at a depth of 5172 feet. The "reef" is 181 feet thick and has a total gas column of 106 feet. The initial natural production from the well was 200,000 cu. ft. gas per day. An 86-foot interval from 5184 feet to 5270 feet was treated with 13,000 gallons of 28% HCl and 10,000 gallons of 15% HCl resulting in an initial after-treatment production of 3,000,000 cu. ft. gas per day.

Pennzoil drilled a second "reef" test in November 1975. The #1 Arthur Reeves is located southeast of the town of Smethport in McKean County, and approximately 9 miles southeast of the Amoco discovery well.

This well encountered Onondaga at a depth of 4694 feet, but no reef facies was observed. The total Onondaga thickness here was 33 feet, and the portion of the Onondaga which is equivalent to the reef facies (Edgecliff Member) was only 11 feet thick and consisted of interreef grainstones with a porosity of approximately 9%.

Fairman Drilling Company has staked a location for a third reef test just north of the town of Mount Alton and just east of the Bradford Airport in McKean County. This location is approximately 3.1 miles southwest of the Amoco discovery.


McKEAN CO.
BRADFORD
SMETHPORT
KANE
AMOCO #
"REEF" 181
LOCATION
DRILLING CO.
Gas production
Show gas
Dry hole
20 Well location and thickness of Onondaga Formation
20 Well location and thickness of Edgecliff Member - Onondaga Formation
0 5 10
MILES
60 Isopach Onondaga Formation
Isopach Edgecliff Member (reef facies) Onondaga Formation
Contour interval = 10 feet
Data taken from drillers logs, sample descriptions, gamma-ray log interpretations

Isopach map of total Onondaga Formation and Edgecliff Member of the Onondaga Formation in McKean County.

This location is in an area where the total regional Onondaga thickness is around 50 feet and where the Edgecliff Member of the Onondaga is less than 10 feet thick (Fig. 1). The Edgecliff Member is also observed to thicken away from the thinner area, indicating a possible platform as in New York. This would be an ideal location for reef growth. The situation in McKean County is similar geologically to Steuben County, New York, where the first Onondaga reefs were discovered. The area of thin Onondaga and thin Edgecliff extends from northeast to southwest through McKean County. Additional discoveries are expected in this trend; and as the well head price of gas increases, these "reef" objectives will become increasingly attractive.

Flooding and Flood Protection at Harrisburg

by
Joan J. Sevon

Floods are naturally occurring events which cause problems for man when he builds his cities on a river's emergency overflow course, the flood plain. Harrisburg suffers severe flood damage because the Susquehanna River and Paxton Creek flood plains are highly urbanized areas containing many residences, businesses, and industries. Flood waters come from the Susquehanna into the southern (Figure 1) and northern parts of Harrisburg and from Paxton Creek, the local major tributary, through the center of the City (Figure 2). Data from the U.S. Geological Survey Water Resource Records show that bankfull stage, 17 feet or elevation 307.0 feet msl (mean sealevel) at the Nagle Street gage, has been exceeded at Harrisburg 29 times since 1784. Figure 3 shows the maximum yearly river stages for years of record between 1787 and 1975. Prior to June 1972, the flood of record was the March 1936 flood.

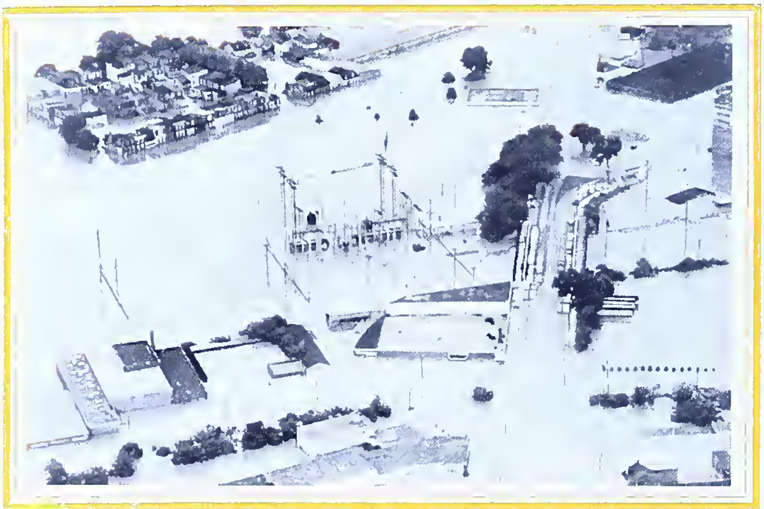


Figure 1. Flooding in south Harrisburg at the intersection of Second and Paxton Streets during the Agnes flood. Photograph from Pennsylvania Power and Light Company.

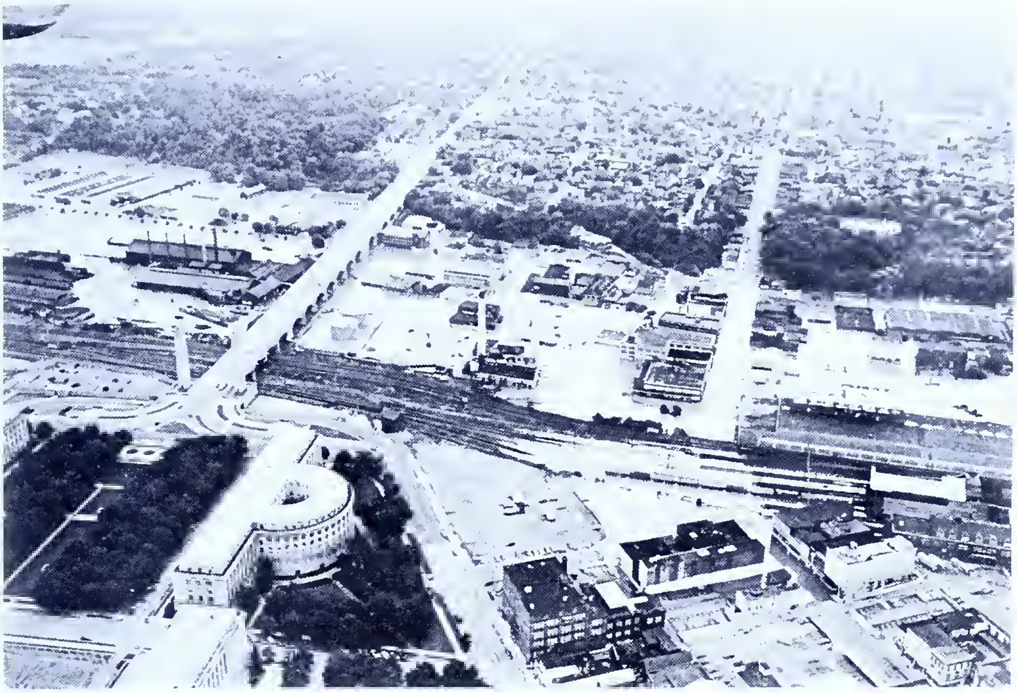


Figure 2. Paxton Creek flooding through the center of Harrisburg during the Agnes flood. Photograph from Pennsylvania Power and Light Company.

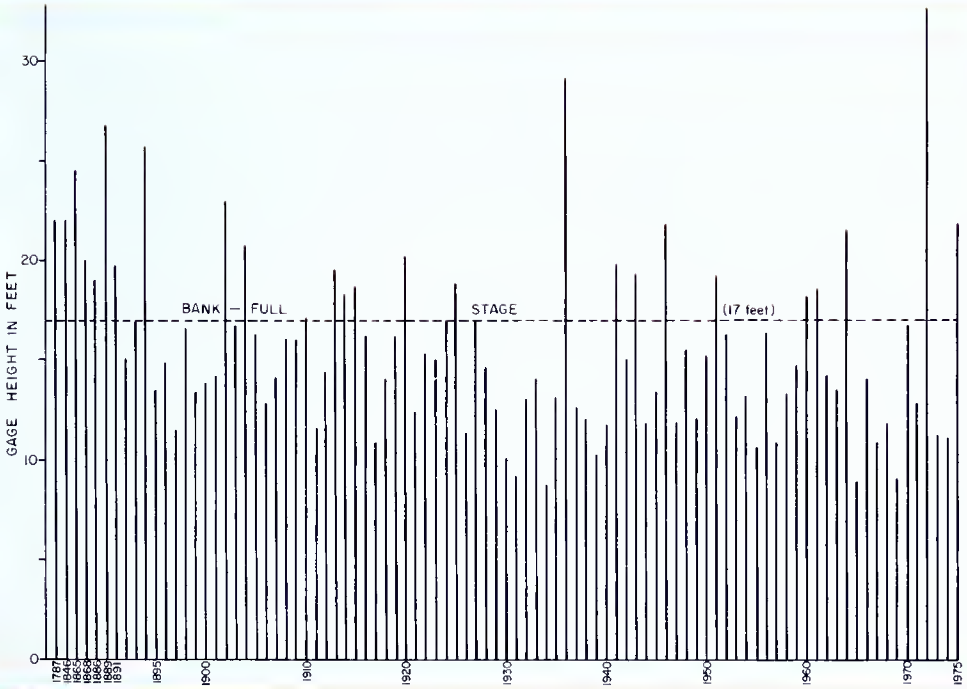


Figure 3. Maximum yearly river stages, 1787 to 1975.

Prior to the March 1936 flood, two to four inches of rain fell in the Susquehanna River Basin on March 11 and 12 . Frozen ground created rapid runoff conditions, and melting snow from above average snowfall augmented the rain. The River rose to high levels and did not have time to recede before an additional one to seven inches of rain fell on March 17 and 18.

Water flowed into Harrisburg early on March 18. The peak discharge of 740,000 cfs (cubic feet per second), 29.2 feet at the Nagle Street gage, came during the evening of March 19 and caused $3 million worth of damage. Flood protection became a vital issue, but no construction resulted.

Somewhat different meteorological events caused the 1972 flood. The 1972 flood was the direct result of Tropical Storm Agnes. Agnes did not loop away to the northeast and the Atlantic Ocean as hurricanes generally do, but hooked back into southern New York State and central Pennsylvania where it dumped 4 to 18 inches of rain between the 20th and 25th of June. Already saturated soil caused by frontal showers (June 12 to 16) contributed to rapid runoff and very high discharge (1,020,000 cfs, Nagle Street gage).

The flood crested at Harrisburg in the early hours of June 24 at 32.5 feet (elevation 322.6 feet msl, Nagle Street gage). Fifteen thousand five-hundred and eighty-four acres (22.4 percent of the City's land area), 9,702 residences, and many businesses were flooded. Harrisburg suffered an estimated $85 million in damages, and four persons lost their lives in the City. Because of the tremendous loss, interest in flood protection stirred again. The U.S. Army Corps of Engineers (hereafter referred to as Corps) completed a flood-control study and proposal, but again no construction materialized before the River once more left its banks.

Tropical Storm Eloise was the direct cause of the most recent flooding at Harrisburg. The Susquehanna reached an elongated peak in the afternoon of September 27, 1975. Gage height at the new City Island gage was 23.81 feet (elevation 313.82 feet msl), and the discharge was 553,000 cfs. This time flood waters did approximately $600,000 worth of damage. And flood protection is once again a vital issue.

Interest in flood control at Harrisburg has intermittently waxed and waned since its first consideration in 1917. The latest flood-control plan submitted by the Corps (U.S. Army Corps of Engineers, 1974) includes the following provisions for protection against an Agnes level flood (see Figure 4):

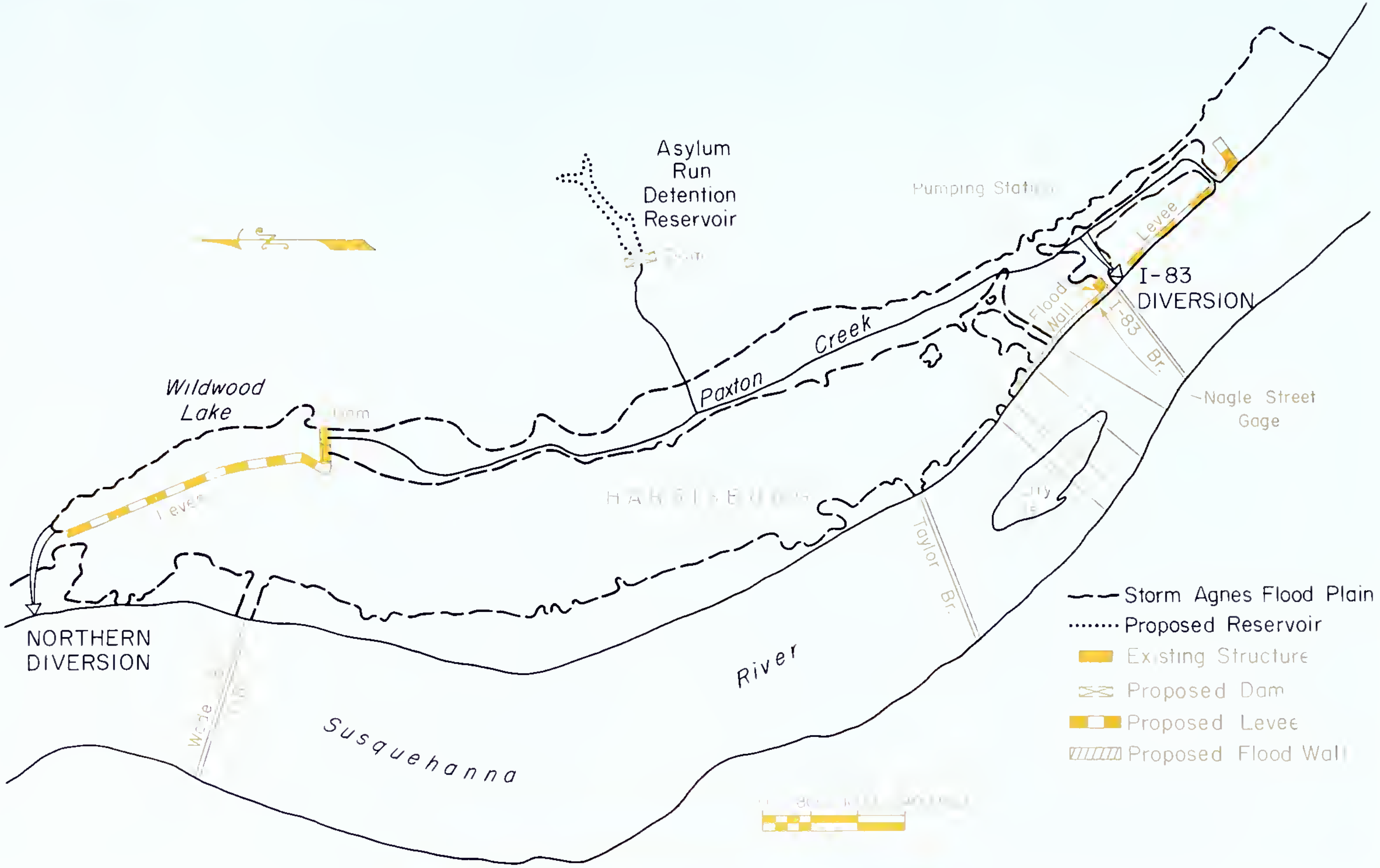


Figure 4. Flood protection proposal.

1) Along Paxton Creek: Wildwood Lake: Wildwood Dam and an upstream diversion from Wildwood Lake to the Susquehanna River provide a small amount of flood control for the City of Harrisburg. They were built in 1912 and have become increasingly ineffective over the years due to the rise in normal lake level caused by siltation and increased runoff from the rapidly urbanizing upper Paxton Creek drainage basin. The Corps plans, therefore, to raise Wildwood Dam 10 feet and dike up the west shore of the Lake to increase the present capacity of the Lake by approximately 1,900 acre feet. Improvements would be made to the northern diversion and the southern outlet through the Dam to carry 4,300 cfs flow from the northern structure and 400 cfs from the southern outlet.

Asylum Run Detention Reservoir: Asylum Run drains approximately 2.7 square miles and enters Paxton Creek about 9,600 feet below Wildwood Dam. Plans for this area include an earth-fill dam making possible a detention reservoir which would hold 410 acre feet at capacity.

Interstate-83 Diversion: The Corps recommends diverting the entire flow of Paxton Creek through a storm drain into the Susquehanna River just below the Interstate-83 bridge across the Susquehanna. The drain is designed to carry 2,520 cfs flow and has gate closures on the Susquehanna side to prevent back-up from the River.

2) In the southern part of Harrisburg: Plans for this area are a subject of controversy. One plan includes a pumping station to pump out interior runoff from behind a reinforced concrete wall 18 feet high by 3,000 feet long and an earth levee 6,000 feet long located 100 to 150 feet back from the River. Another plan puts the wall approximately 800 feet inland from the River to pass behind the area known as Shipoke, thus preserving the residents' unobstructed view of the Susquehanna. This plan, however, would leave 800 residents and 183 buildings worth $4.5 million, including the City's sanitary pumping station, without structural flood protection; the consequences are illustrated in Figure 1.

3) In the northern part of Harrisburg: Plans for adequate protection by flood walls, levees, and pumping stations along the Susquehanna are currently economically unfeasible and are, therefore, not considered in the overall plan. The Corps recommends flood proofing, building codes (minimum elevation, proper anchorage), and evacuation at flood warnings for north Harrisburg.

Unfortunately, these plans appear to be in limbo at the present time. Some time ago Harrisburg City Council indicated its willingness to enter into a contract for the flood protection outlined above, including the flood wall 100 to 150 feet back from the River at Shipoke. Escalating costs due to engineering problems at the Wildwood Lake site and inflation have now put the cost for the entire project beyond the acceptable cost/benefit ratio.

Harrisburg, however, is currently trying to put the cost/benefit ratio back within acceptable limits. The City is reevaluating its urban renewal projects in flood-prone areas and lumping together the City's damage estimates from the 1972 and 1975 floods, thus increasing the "benefits" of flood control. Also, the Corps is investigating the possibility of increasing the capacity of Paxton Creek rather than raising the Dam and constructing levees at Wildwood Lake. In the meantime, Harrisburg's flood-prone areas remain as they have been through 29 floods: without sufficient flood protection.

Reference Cited

U.S. Army Corps of Engineers, 1974, Harrisburg local flood protection study, survey report, Paxton Creek and Susquehanna River, Harrisburg, Pennsylvania: Dept. of Army, 60 p. and Appendices.

pennDOT issues map catalog

The Pennsylvania Department of Transportation has issued a brochure (Publication #120) entitled "Your guide to maps as published by Pennsylvania Department of Transportation." This publication lists the various maps available through the Department of Transportation. The Pennsylvania Department of Transportation issues several series of maps, largely related to highway and traffic systems, as well as a political subdivision map, a construction bulletin, and an official transportation map. Copies of this catalog may be obtained free of charge by requesting Item No. 0350-5300-1200 from PennDOT Publication Warehouse, Harrisburg International Airport, Middletown, Pa. 17057.

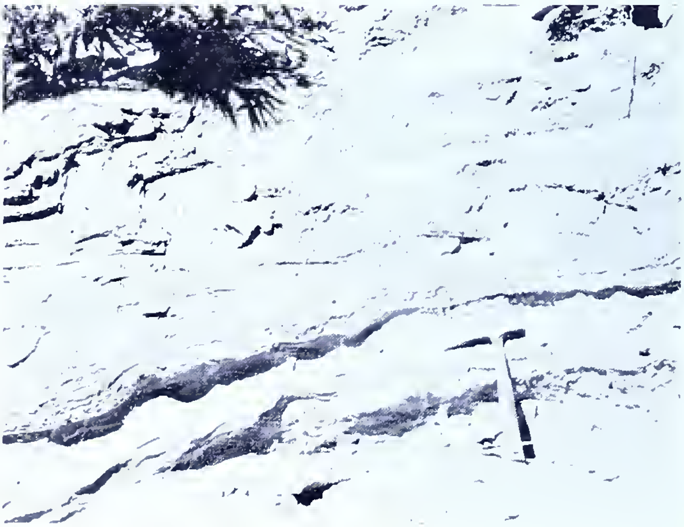
York Mineral and Gem Show

The York Rock and Mineral Club will hold its 7th Annual Mineral and Gem Show on April 3rd and 4th at the Manchester Township Fire Company #1 on Pennsylvania Route 181 at Emigsville.

GEOLOGISTS EXAMINE GLACIATION IN NORTHEASTERN PENNSYLVANIA

Monroe and Carbon counties were the focus in early October of a two-day field conference attended by 127 geologists from Pennsylvania, Virginia, West Virginia, Massachusetts, New Jersey and New York. The annual Field Conference of Pennsylvania Geologists was hosted by the Pennsylvania Geological Survey and was conducted by Messieurs William Sevon and Tom Berg of the Survey, and George Crowl of Ohio Wesleyan. The conference featured two days of trips,

Participants in 40th Annual Field Conference of Pennsylvania Geologists examine a new vertical exposure of Altonian (Mid or Early Wisconsinan) ice-contact stratified sand and gravel overlain by Altonian glacial till.



Unconsolidated and formerly horizontally stratified layers of sand, silt and clay have been deformed by pressure from Altonian ice which moved from right to left about five feet above these layers. The direction of movement is indicated by the fold.

Roger Faill, Pennsylvania Geological Survey, considers the structural implications of small folds in unconsolidated sand and gravel layers. These folds were created by pressure from Altonian ice which moved from right to left over the sands and gravels.

visiting many localities where unconsolidated sediments deposited by the Illinoian, Altonian and Wisconsinan glacial epochs (100,000? to 10,000 years ago) are well exposed. The geologists were treated to many exposures of glacial till and colluvium and had an unusual opportunity to examine the differences between these kinds of deposits. Also observed were examples of disruption of original sedimentary layering which had resulted from the friction of overriding ice (Figure 2) during the glacial advance.

The 1976 meeting of the Field Conference of Pennsylvania Geologists will be conducted by staff of the Geology Departments of Edinboro and Slippery Rock Colleges and will be centered in the Oil City-Franklin area from September 30 through October 2, 1976.

NEW SOIL SURVEY ISSUED

Soil Survey of Franklin County, Pennsylvania, by R. S. Long. U.S. Dept. of Agriculture, Soil Conservation Service, 1975.

This publication includes written descriptions as well as a soil association map. It is useful to people who want a general idea of the soils in the county, or want to compare soils in different parts of the county or who want to know the location of large tracts that are suitable for a specific kind of land use.

Single copies of Franklin County report are free from Soil Conservation Service, 550 Cleveland Avenue, Chambersburg, Pa. 17201.

SURVEY ANNOUNCEMENTS

PENNSYLVANIA OIL AND GAS DEVELOPMENTS IN 1974 PUBLISHED

The annual report in Pennsylvania's oil and gas developments clearly points up the increased exploration, drilling, and production which has resulted from the energy crisis and the accompanying price increases.

Indiana County was the most active area in Pennsylvania in development of gas resources. Here 319 new wells were drilled in 1974. Venango County has the highest number (224) of wells drilled for oil during this same period. Shallow gas production increased 5%, deep gas production was up 10% and Pennsylvania grade crude oil production was up 4% during 1974 over 1973. During the year Pennsylvania had 32,095 oil wells and 17,123 gas wells in production. These and many other facts on oil and gas production in Pennsylvania are included in the recently published report "Oil and Gas Developments in Pennsylvania in 1974" by William S. Lytle. This publication, PR 188, is available for $1.50 (plus 6% sales tax for Pennsylvania residents) by writing to the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125.

NEW BASE MAP OF PENNSYLVANIA ISSUED

The Bureau of Topographic and Geologic Survey announces the publication of a new base map of Pennsylvania. This map measures 6½ x 5 feet and comes in two sheets, eastern and western halves, each with a two-inch overlap so that the halves can be joined into one map. Both halves are included in an envelope. The map contains roads, railroads, towns, town names, county boundaries and county names printed in black, as well as streams, lakes, reservoirs with their names printed in blue. Townships, boroughs and city boundaries and their names are printed in pink. Latitude and longitude tick marks appear in black and the Pennsylvania State Plane Coordinate tick marks appear in blue. The new map is at a scale of 1:250,000 (1 inch equals 4 miles). This map can be used for a wide variety of purposes; it will be used as the base for the new geologic map of Pennsylvania currently being prepared. The base map of Pennsylvania, Map #41, is available for $8.80, plus 6% sales tax for Pennsylvania residents, by writing to the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125. Both halves are sold as one unit.

SURVEY ISSUES PUBLICATIONS ON HARRISBURG AND McCONNELLS MILL STATE PARK

Two new free publications of general interest have just been released by the Bureau of Topographic and Geologic Survey. One of these is *Park Guide 9,* a 6-page fold-out pamphlet of the geology of the Slippery Rock Creek Gorge in McConnells Mill State Park. This brochure illustrates the geology seen in the gorge through map, sketch and photograph. Copies of *Park Guide 9* may be obtained at McConnells Mill State Park or by writing to the Bureau of Topographic and Geologic Survey, Department of Environmental Resources, P.O. Box 2357, Harrisburg, Pa. 17120.

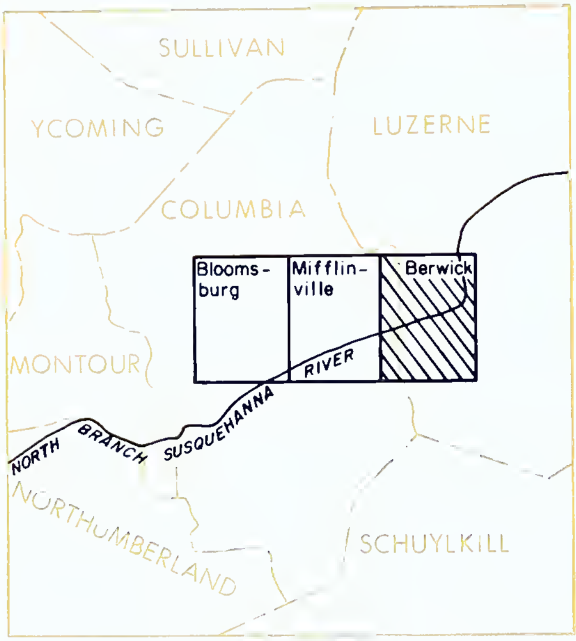
Residents of the Greater Harrisburg Area may be interested in a new map (*Map #48*) issued by the Pennsylvania Geological Survey covering the area from Hershey to Mechanicsburg and south to Goldsboro, showing the distribution of the major kinds of rock units present as bedrock in the area. Areas underlain by limestone, shale, sandstone and diabase are shown on this generalized map which measures approximately 13 x 14 inches. This map may also be obtained free of charge by writing to the bureau address.

PENNSYLVANIA SURVEY'S BEST SELLERS

During the past two years the popularity of G 40, *Fossil Collecting in Pennsylvania,* and G 33, *Mineral Collecting in Pennsylvania,* has continued unabated. G 40 has been our #1 seller for 1974 and 1975 and G 33 was #2 even though it has been out of print since August 1975. The new edition of G 33, due to be printed in Spring, 1976, should be a top seller again. Our Map #1, the *Geologic Map of Pennsylvania,* is tops of the map series with the *Topographic Map of Lehigh County* selling in #2 place.

Energy was the major concern of our book buyers in 1975 with our bulletins M 68, *Bituminous Coal Resources in Southwestern Pennsylvania,* M 69, *Analyses and Measured Sections of Pennsylvania Bituminous Coals,* M 6, *Bituminous Coal Fields of Pennsylvania, Part 2,* and IC 72, *Coal Reserves of Pennsylvania,* selling in the 3rd, 5th, 8th and 9th places among all our publications. Tenth place was shared by parts 3 and 4 of Bulletin M 6. The two guidebooks to the geology of the Philadelphia and Pittsburgh areas sold in the 4th and 6th places. The annual Oil and Gas Developments report (PR 187) was in 7th place, up from 10th place (PR 186) in 1974.

Environmental Geology reports slipped from the top 10 in 1975 but were in 4th (EG 1) and 8th (EG 2) places in 1974.

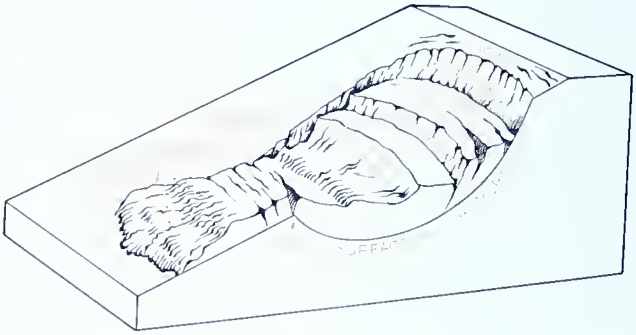


Geologic Survey Starts Berwick-Bloomsburg Mapping Project

The Pennsylvania Geological Survey has initiated a project to map the bedrock and surficial geology of the Berwick 7½′ quadrangle in Columbia and Luzerne Counties, Pennsylvania. This is the first stage of an areal mapping program which will provide the basic information necessary to evaluate the mineral resources, ground water potential, and environmental hazards along the North Branch of the Susquehanna River. This is a developing area as a result of new Routes 80 and 81, the new power plant under construction, and the increased recreation in the region.

Mapping in the Berwick 7½′ quadrangle will be carried out by staff geologist Dr. Jon D. Inners. It is anticipated that the project will be completed in 1977. Subsequent geologic mapping is planned for the Mifflinville and Bloomsburg quadrangles immediately to the west.

USGS ISSUES CIRCULAR AND MAP ON landsliding



The U. S. Geological Survey has just published Circular 728, "Landsliding in Allegheny County, Pa."

This circular includes general descriptions of landslides, slump, earthflow, rock fall, debris slide and creep. It includes recommendations for homeowners, buyers and builders on what to look for and avoid in selecting a homesite. Descriptions are given of 15 specific landslides encountered in this area.

Although Circular 728 concerns Allegheny County, the same conditions prevail in many western Pennsylvania counties and the recommendations are applicable outside Allegheny County as well as other regions and other states in the Appalachians where landsliding is a problem.

Circular 728 has a companion map, #MF 685B, "Map of Susceptibility to Landsliding, Allegheny County, Pa." This map shows where landslides have occurred and are likely to occur in Allegheny County.

Circular 728 is free; Map #MF 685B is available for $1.00 by writing to: Branch of Distribution, U.S. Geological Survey, 1200 S. Eads Street, Arlington, Va. 22202.

U.S. GEOLOGICAL SURVEY ISSUES UNION COUNTY TOPOGRAPHIC MAP

As a product of the cooperative county mapping program with the Pennsylvania Geological Survey, the U.S. Geological Survey has recently issued a new topographic map of Union County. This new map is at a scale of 1:50,000 (approximately 4000 ft. to the inch) and follows the previously issued maps of Sullivan, Montour, Jefferson, and Forest counties. As is standard with this new series of county maps, contours are shown in brown at 20-foot intervals, cultural features are shown in black with major roads and urbanized areas in red, forested areas are green, water features are blue, political boundaries for county, townships, and boroughs are outlined in orange. The county map is of widespread use to all who are concerned with county and regional planning, engineering, agricultural, and recreational projects. This map can be obtained for $2.00 by writing to Distribution Section, U.S. Geological Survey, 1200 South Eads Street, Arlington, Virginia 22202.

New From the U.S. Geological Survey

U.S.G.S. Bulletin 1409. *A summary of oil and gas production and reserve histories of the Appalachian basin, 1859–1972,* by B. M. Miller. 1975. Price: $0.70

A summary of the oil and gas production and reserve histories of the Appalachian basin, including Pennsylvania, from 1859–1972, compiled on the basis of published information from State and Federal agencies, private agencies, and petroleum companies. Summary compilations categorized by State and geologic age are reported for the distribution of the estimated total proved recoverable hydrocarbons in the Appalachian basin. A detailed bibliography is included.

U.S.G.S. Miscellaneous Geologic Investigations Series Map I-844. *Geologic Map of the Surficial Deposits in the Trenton Area, New Jersey and Pennsylvania*, by J. O. Owens. 1975. Scale 1:48,000. Price: $1.00

U.S.G.S. Miscellaneous Geologic Investigations Series Map I-917, Part C, Part D, *Oil and Gas data from the Appalachain basin,* by R. L. Miller. 1975. Price: $1.75 each. Scale: 1:2,500,000.

These maps are part of a folio of Appalachian basin oil and gas data. Chapter C shows by isopach maps the extent and thickness of the carbonate and clastic facies of the Upper and Middle Ordovician rocks in the Appalachian basin, including Pennsylvania, as well as the total thickness of these strata. Configuration of the basin is shown by structure contours. Generalized areas of oil and gas production are delineated.

Chapter D shows by isopach maps the thickness and extent of the Lower Ordovician and Cambrian rocks in the Appalachian basin, including Pennsylvania. Structure contours on the top and base of these strata emphasize the importance of growth faulting during the Cambrian. The complex relation of lithofacies in the Lower Ordovician and Cambrian rocks is shown by a series of conceptual geologic cross sections.

U.S.G.S. publications are available from: Branch of Distribution, U.S. Geological Survey, 1200 S. Eads Street, Arlington, Va. 22202.

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Robert C. Smith, *Geologist*

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1201 Kossman Bldg.
100 Forbes Ave., Pittsburgh, Pa. 15222
William S. Lytle, *Division Chief*

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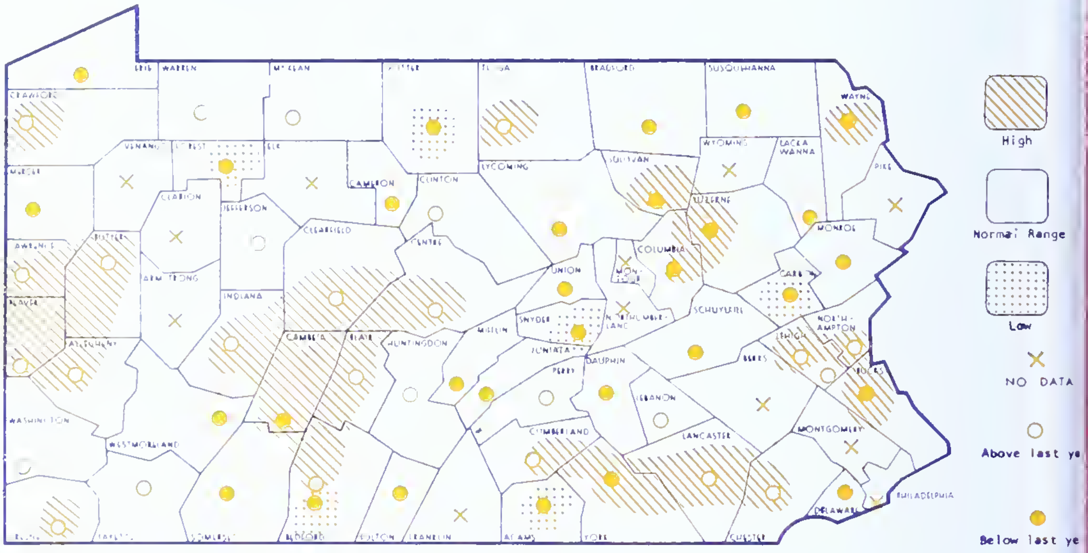

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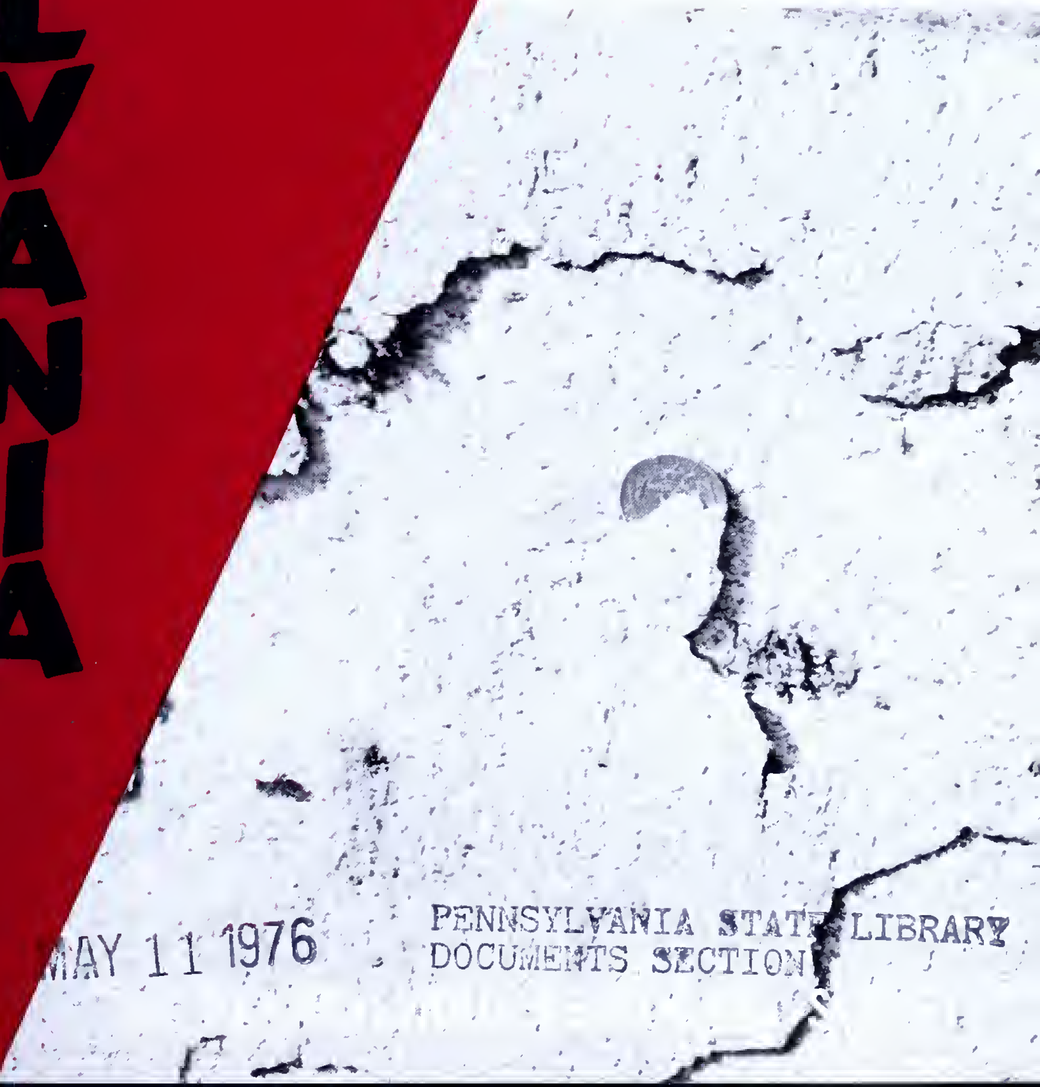

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Cover Photo: Even rocks decompose! Close-up view of granite foundation stone exposed to Harrisburg elements since 1930. Coin (quarter) in photo gives scale. Photo courtesy of William Bolles.

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APRIL 1976

FROM THE DESK OF THE STATE GEOLOGIST...

PENNSYLVANIA'S IRON AGE

Today, Pennsylvania has only two operating metal mines: the Grace Mine (iron ore) at Morgantown and the Friedensville zinc mine near Bethlehem. But it was not always thus. Over the past 200 years, Pennsylvania has had a history of metal mining almost unmatched in numbers and variety. The remains of thousands of such mines are scattered across the Commonwealth and the range of commercially produced ores includes iron, nickel, chrome, manganese, zinc, lead, copper, gold, silver, magnesium, graphite, cobalt, and uranium.

Pennsylvania's iron mines, amongst all the various metal mines, offer the longest history and the greatest number of former operations across the Commonwealth. Our first iron furnace, based on local ore and charcoal, was built in 1716. Best known of former producers was the world famous Cornwall iron mine, Lebanon County, which was in continuous production from 1742 to 1972. The same type of magnetite iron deposit (with sulfides) was mined at Boyertown, Wheatfield, Fritztown, Jones, Fritz Island, and Joanna (all in Berks County); French Creek, Warwick, Knauertown, and Hopewell in Chester County; Dillsburg, Grantham, and Wellsville in York County.

A different type of magnetite ore, concentrated in older, crystalline rocks, was mined in Berks County in the Seisholtzville area, where over 120 mines were developed in nearby Rittenhouse Gap over a stretch of about two miles. This type of magnetite ore was also produced near Vera Cruz, Lehigh County, starting before the Civil War; at this location in 1899 Thomas A. Edison conducted a magnetic survey over the grounds and mapped out an additional 20,000,000 tons of iron ore.

Yet even this is only part of Pennsylvania's great iron mining history. From the difficult terrain of central Pennsylvania's Ridge and Valley Province, scores of mines produced from the sedimentary Clinton hematite formation in Snyder County (Adamsburg, Centerville, Paxtonville, Beavertown), Mifflin County (Yeagertown, Lewistown, McVeytown), Juniata County, Blair County, Huntingdon County (Orbisonia, Mt. Union, Shirleysburg), Union County (Winfield, New Berlin), and Bedford County. This is the same formation which extends southward through the Appalachian Mountains and thickens in Alabama to form the basis for the Birmingham steel industry. In Pennsylvania the limited thickness, low grade, and undesirable impurities eventually brought this mining to an end.

Early in Pennsylvania's iron mining industry a large number of "brown iron ore" deposits were in production, formed in some places in small swamps, and in other places as residual concentrations from weathered limestone bedrock. These were worked in Chester,

(Continued on page 9)

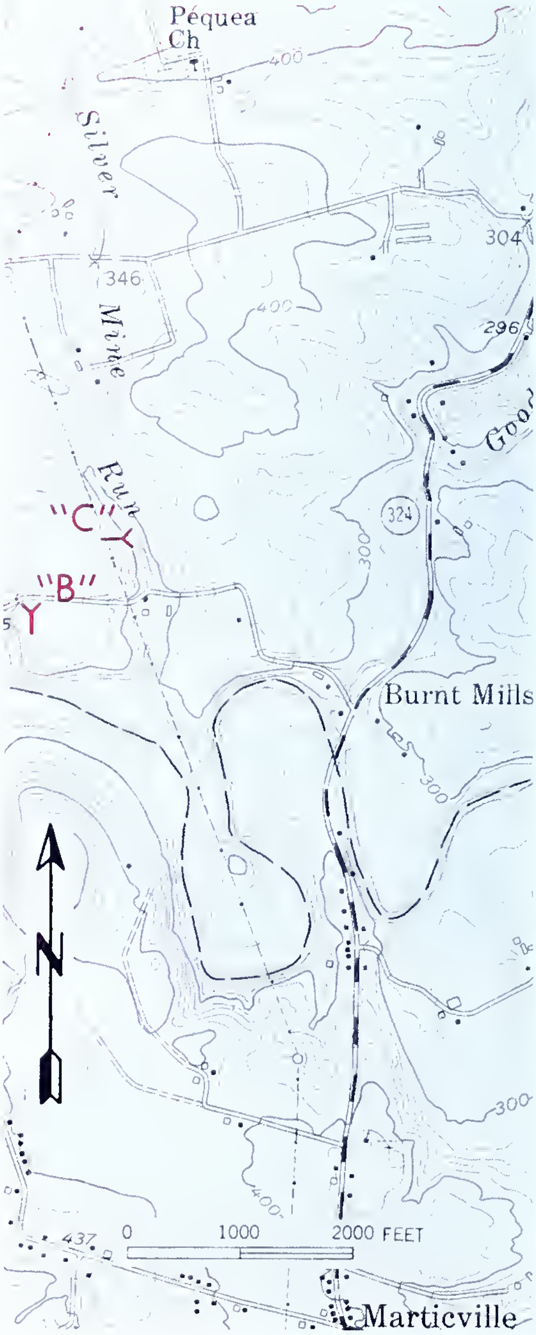
THE HISTORY AND MYSTERY OF THE PEQUEA SILVER MINES

by
Alan R. Geyer

The Pequea Silver Mines, located about five miles south of Lancaster in Lancaster County, were operated off and on for a period of more than 200 years, and perhaps even more than 300 years. Today evidence remains of three mines and a vertical shaft, but no one really knows what workings are actually below the ground there.

The mines involved extensive tunnels in solid limestone and dolomite developed by miners over these hundreds of years as they followed quartz veins containing the silver-bearing lead ore called argentiferous galena. The ore occurs in small, thin, discontinuous veinlets scattered throughout the enclosing rock. These elusive veinlets may account for the sporadic mining activity and a poorly recorded history.

There is evidence that the Pequea silver mines were worked by the Indians prior to 1643. In a book titled "A Key Into the Languages of America" by Roger Williams in 1643, he states that the Indians developed an art to cast pewter and brass into very neat, artificial pipes. In the late 1920's,



Mr. D. H. Landis, of Lancaster, had some lead pipes in his collection that were taken from the graves of Indians located south of Washington Boro, about eight miles from the mine area. On the thought that these pipes may have been made from lead mined at the Pequea mines, he had one analyzed. It was found that the lead in the Indian pipe contained the equivalent of 250 oz. of silver to the ton, exactly the same amount as one analysis of the argentiferous galena taken from one of the Pequea mines.

Early Colonial records (pre-1709) mention that the Indians of Conestoga were "pressed" into service in the mines. When William Penn heard of this he wrote James Logan and instructed him to verify the presence of a mine and to collect royalties from it for Penn. No records exist to show whether or not Penn received any royalties.

R. C. Smith II at Entrance to Burnt Mills Mine.

The Shawanese Indians came to Lancaster County about 1678 and settled along Pequea Creek near Conestoga. A Mr. D. J. Eckman, about 1927, discovered the site of a large Indian village near Silver Mine Farm. Here, he found evidence of the Shawanese and an earlier Indian culture. Was it the Shawanese Indians that worked the mines during Penn's time? Since the Shawanese came to the Pequea Creek in 1678, what tribe lived here before 1643? Did these earlier Indians discover and work the Pequea mines and if so, when?

There are only tales of the mines being operated periodically from Penn's time to the close of the Eighteenth Century. During the Revolutionary War, it is said the mines supplied lead shot for General Washington's troops but this may be only a tall tale because of the small amount of lead ore available. Many years later, during the Civil War, miners were blasting for a new shaft and accidently discovered an old mine drift with several cross cuts. Within these old workings, they found several English powder cans and a rod for cleaning the dust out of drill holes. The entrance to these old tunnels was never found; it probably lies below the present water table.

In 1853, the "Journal of Silver and Lead Mining Operations" reported the mines being run with "considerable vigor." At the same time, the editor of the "Lancaster Whig" stated that recent assays by a Dr. Fahnestock (possibly of Lancaster) and by Professor Booth of the U.S. Mint in Philadelphia showed the ore contained "upwards of five hundred dollars ($500) worth of silver to the ton of lead." Mr. Booth states that there was about two tons of ore lying on the ground when he made his geological examination in 1853.

During the early part of the Civil War, mining was carried out by a Captain Joseph Buzzo. Local opinion has it that Captain Buzzo got considerable silver from the operation, but no record of this period has been found. How did a Captain of the Union forces become engaged in mining lead and silver at the Pequea mines when his country was at war? Did the U.S. Government sponsor it?

Sometime during the latter part of the Civil War, a group by the name of Lancaster Lead Company acquired the mines and tried to sell stock to reopen them. A company prospectus (dated 1863) describes much of the mining activity of that period. From this description, it appears that most of the mine workings visible today were completed by 1863.

After the Civil War the mines were inactive until 1874 when a silversmith from Philadelphia, Mr. Harvey Filley, purchased and operated the property. This venture was short-lived but during its one-year life, a mine superintendent, a mineralogist, and many miners were employed.

Geological investigations at the Pequea mines from the 1930's to date have been conducted by the Geology Department and the North Museum at Franklin and Marshall College in Lancaster. Since 1946, the Department's staff and students have studied this area and members of the Pennsylvania Geological Survey staff have periodically examined and sampled the site.

The total production of lead and silver from the Pequea mines is difficult to estimate. No production records exist for either the pre-Colonial or Colonial activities. Two tons of galena-bearing ore (perhaps contianing 5% galena) were mentioned in 1853 and in 1863 the Lancaster Lead Company claimed production of about 10 tons of galena. Estimations based on accessible mine openings and on known other underground workings indicate that 3,500 to 5,000 tons of rock have been mined. Approximately this amount (3,500 to 5,000 tons) has also been quarried at the surface. On the order of 10 tons

Entrance to Mine "C" at Silver Ford along Silver Mine Run.

of galena may have been mined but little of this may have been recovered from the stockpiles and smelted.

Today several mine openings are visible; several additional mine openings are completely slumped or filled; underground workings, drifts and crosscuts are present, no one knows how extensive.

Now a new chapter to this history has been written. The mine property is known as Silver Ford, Inc. and is owned and operated by Mr. James R. Bunting. Mineral collecting, a tour of one of the mines, and the use of all picnic and recreational facilities are available on a fee basis. All arrangements may be made by writing P.O. Box 1137, Lancaster, Pennsylvania 17604.

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ENGINEERING PROBLEMS in areas of limestone springs

by
Samuel I. Root

Boiling Springs, the largest spring in Cumberland County with a median flow of 11,500 gallons per minute ranks 7th in size of springs in the Commonwealth. It is one of the most charming and picturesque areas in the Great Valley.

Most of the major springs in Pennsylvania issue from fissures in carbonate rocks. Limestones, which are among the most solution prone rocks in the state, readily develop an extensive interconnected subsurface drainage network ranging from minute cracks or crevices to wide fissures and caves which combine to maintain a large sustained water yield. Generally, the geologic factors that control the occurrence of a spring are not immediately obvious. They may be due to a particular structure of the rock, variation of rock composition, faulting of the rock, or a combination of these factors.

In the Boiling Springs area those factors that influence the location of the spring are quite evident. The folded Cambrian limestones of the Elbrook Formation at Boiling Springs have been injected by a near-vertical, thin sheet of igneous rock, called a diabase dike. This diabase is virtually impervious to the migration of water and thus acts as a hydrologic barrier. It has an excellent topographic expression forming a narrow ridge—locally termed Stony Ridge—50-100 feet higher than the surrounding limestone terrain. At Boiling Springs the dike splits in two segments, so that the town is located in the interior apex of a "V" formed by the segments (Fig. 1). The general migration of subsurface water in this area is to the north and east from higher elevations on the south. Apparently subsurface waters migrating north becomes progressively confined between the two segments of the impermeable dike until they issue forth from a number of springs at the apex of the two dikes. Immediately northwest of the springs, on the other side of the dike, the bend in the dike also forms a geologic area in which groundwater flow is impeded with a consequent development of solution features.

The presence of a number of springs in limestone rocks in the immediate area is an absolute indication that there are significant fissures and caverns in the area. Therefore, construction in such a region should be preceded by core drilling, or other subsurface investigation, to determine the presence and extent of fissures and caverns in the limestone bedrock.

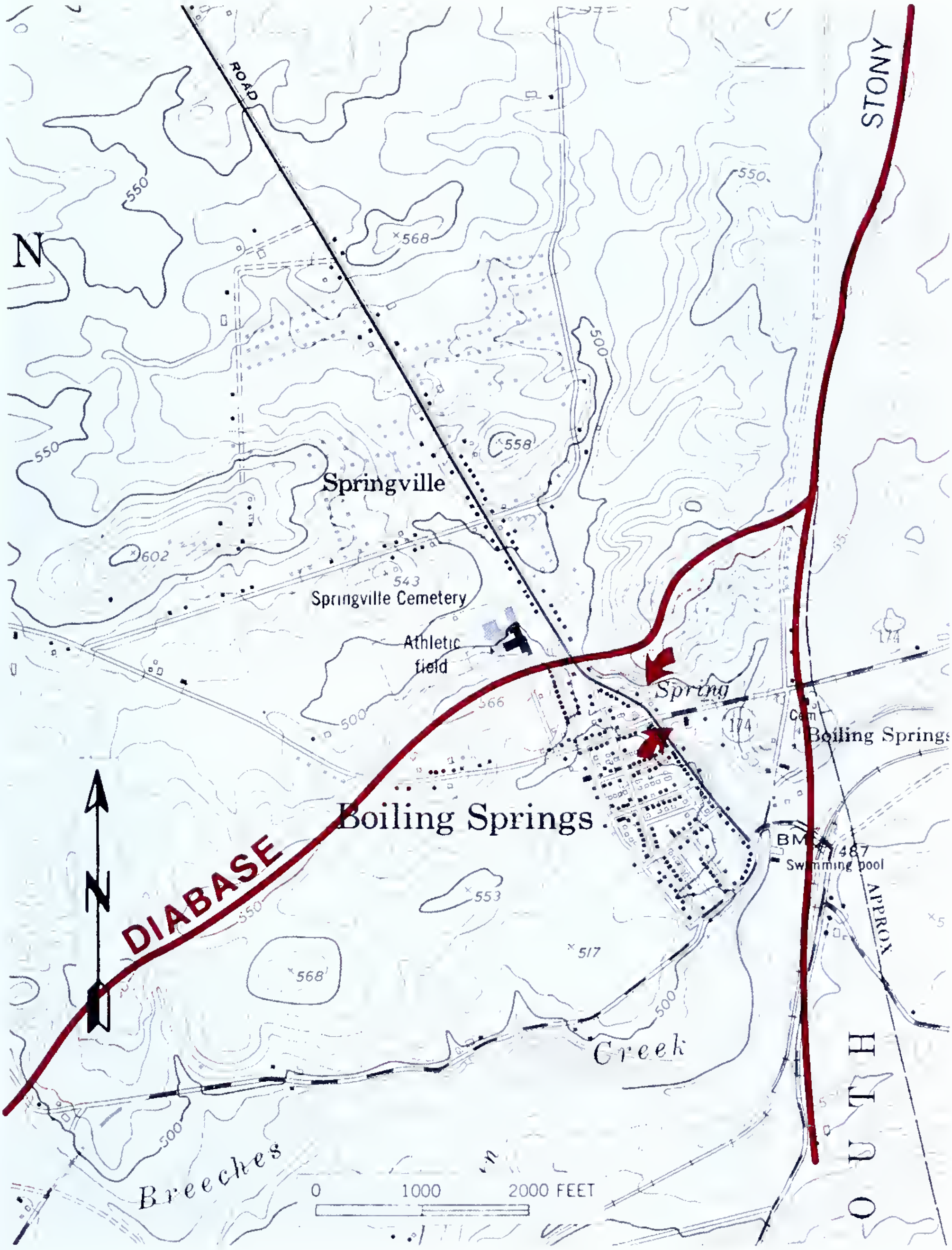


Figure 1.

Recently there have been some construction problems in the Boiling Springs area. A corner section of the new Boiling Springs High School apparently settled into a sinkhole which opened after a series of heavy rains apparently washed out a supportive clay plug (Fig. 2); a more detailed on-site investigation might have prevented such an accident. A number of problems have been encountered dur-

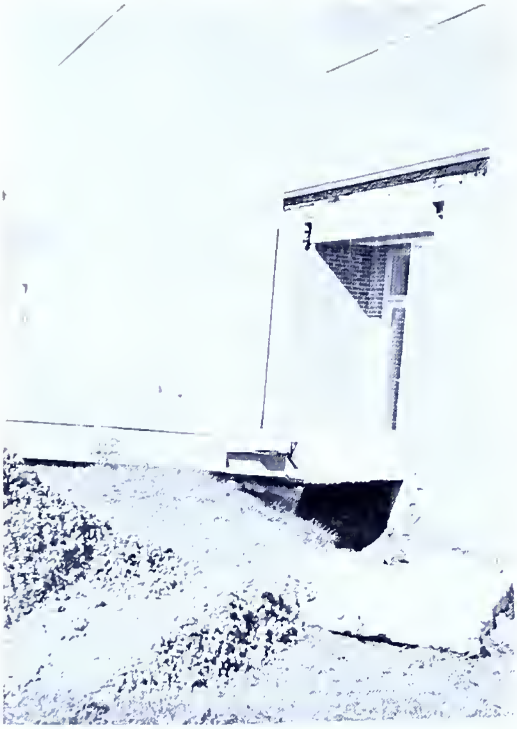
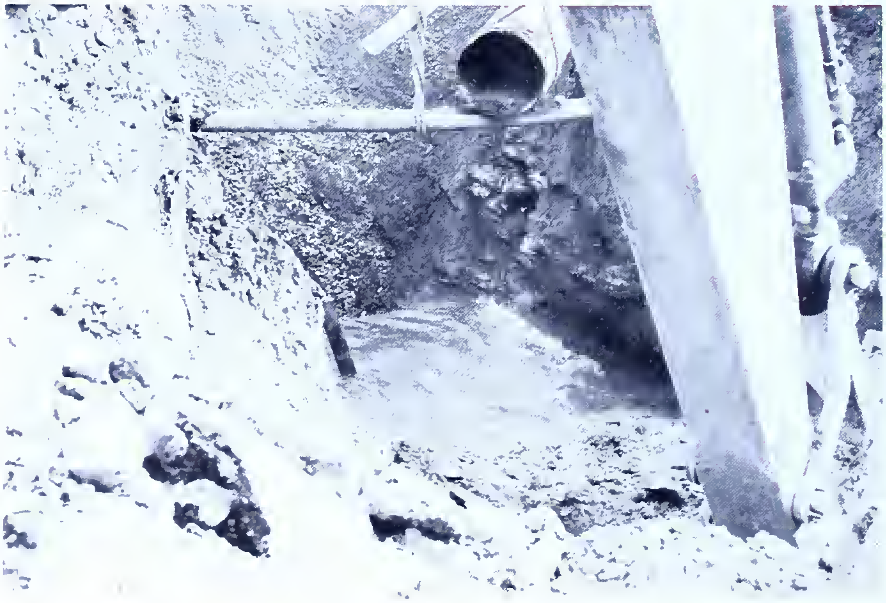


Figure 2. Sinkhole developing beneath entrance to school causing collapse of ground below entrance. (Photo courtesy of J. P. Wilshusen.)

Figure 3. Spring issuing from fissure in rocks, uncovered during excavation of ditch for sewer line.



ing installation of a sewer line. In one instance, excavation of a ditch flushed out a clay plug from a fissure in limestone so that support was withdrawn beneath an old water main which immediately ruptured. In another instance, a ditch excavated between two of the springs exposed a large fissure and intercepted a flow of water to the springs, so that several thousand gallons of water per minute had to be pumped out (Fig. 3) for an extended period. The fissures are developed parallel to a set of fractures which have been mapped in this area. While the presence of a fissure could best be determined by drilling, their orientation, once encountered, might reasonably be predicted from nearby fracture data.

The Pennsylvania Geological Survey has always cautioned about foundation problems inherent in construction on carbonate bedrock. Springs in a carbonate terrain are an indication of potentially troublesome areas and the ground water conditions should be thoroughly investigated prior to construction in such areas.

there's a long, long trail a winding

We recently received a letter from a Scoutmaster with the following request: "Will you please send my troop the following information: any and all information on the Application Trail in Pennsylvania." We did not have the heart to tell him that the "Application Trail" is one of the most difficult and tortuous trails around. Rather, we took the easier way out and sent him some information on the Appalachian Trail.

FROM THE DESK OF THE STATE GEOLOGIST

(Continued from page 1)

Lancaster, York, Centre, and Huntingdon Counties.

Pennsylvania's hundreds of iron mines fed furnaces throughout the Commonwealth and served a vital role in our early economy. Limited reserves and changes in technology and economics gradually brought about the demise of the many small iron mines, but they have left us with a rich heritage, worthy of remembrance in our Bicentennial Year.

Arthur A. Socolow

YORK COUNTY ANNUAL "ROCK SWAP"

The York Rock & Mineral Club Inc. will hold its fourth (4th) Annual "Rock Swap" on Saturday, June 12th and Sunday, June 13th, 1976 at Rohlers Picnic Grounds on Rohlers Church Road. These Picnic grounds are located three (3) miles east of Mt. Royal off Pennsylvania Route 74. Mt. Royal is approximately 2 miles north of Dover, Pennsylvania on Route 74.

For further information, please contact L. Weaver, Public Relations, Grant Road—Box 75, Thomasville, Pa. 17364.

QUIGGLEVILLE GAP PROSPECT–Lycoming County

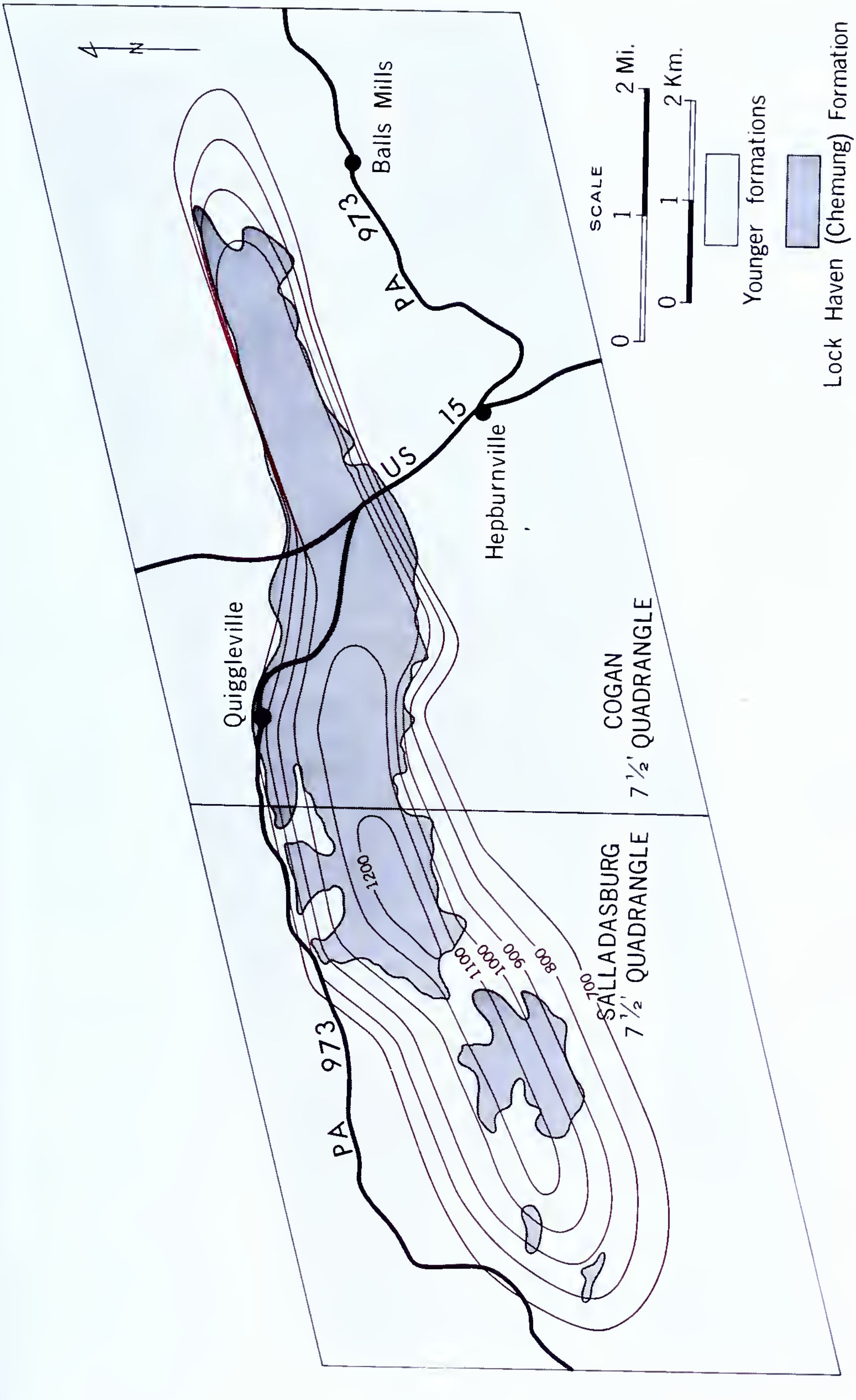
by
Richard B. Wells
Pennsylvania Geological Survey

Recent geologic mapping in central Lycoming County by R. T. Faill and R. B. Wells has outlined an interesting closure on Tomb's Run Anticline. It is the type of structural feature which should be considered for the possibility of containing natural gas. The prospect is located about two miles southwest of Quiggleville in Anthony and Lycoming Townships, on Cogan Station and Salladasburg 7½-minute Quadrangles, Trout Run 15-minute Quadrangle.

The Upper Devonian Lock Haven ("Chemung") Formation is exposed on the crest of the structure, with redbeds of the overlying Catskill Formation present on the flanks. The shallowest formation in which significant porosity and permeability is anticipated is the Lower Devonian Ridgeley (Oriskany) sandstone, which is about 80 feet thick and lies some 7900 feet below the Catskill. In outcrop, the Ridgeley sandstone is white to very light gray, medium and coarse grained, and fossiliferous. It is generally very porous and friable but locally has a calcareous or siliceous cement. The nearest good exposures are in the sand quarries at Lymehurst (one mile east of Williamsport) and Montoursville (three miles east of Williamsport), and along the east side of Pine Creek at Jersey Shore. Analysis of four Ridgeley samples from the Montoursville quarry show an average porosity of 15.6 percent. Sielacher (1968) has described the cementation and diagenesis of the Ridgeley (Oriskany) sandstone.

The formations overlying the Ridgeley Sandstone are predominantly gray shale and siltstone with a few thin limestone units. There are also some very fine grained sandstone beds in the upper 2000 feet of the Lock Haven Formation.

Tomb's Run anticline is the southernmost major fold in the Allegheny Plateau structural province, although it lies about two miles southeast of the Allegheny Plateau front. The fold axis trends about 068° (azimuth) across Salladasburg Quadrangle and about 079° on Cogan Station Quadrangle. It is located about a mile north of the axis of Short Mountain syncline and about three miles south of the axis of Snow Shoe syncline. Tomb's Run anticline has been traced by Colton (1967) from the Swissdale area in Clinton County northeastward into Salladasburg and Cogan Station Quadrangles. Total


N
Balls Mills
PA 973
US 15
Hepburnville
Quiggleville
COGAN 7½' QUADRANGLE
SALLADASBURG 7½' QUADRANGLE
PA 973
1200
1100
1000
900
800
700
SCALE
0 1 2 Mi.
0 1 2 Km.
Younger formations
Lock Haven (Chemung) Formation

length of the structure on the surface is about 23 miles, and present mapping indicates a closure of at least 500 feet on the top of the Lock Haven (Chemung) Formation (Figure 1).

A comparison of the Tomb's Run Anticline with other structures in this region suggests that the fold axis may be dipping to the south at a high angle, rather than vertical. If this is the case, the crest of the fold would be offset to the south in the subsurface.

The nearest gas production is from the Ridgeley sandstone in the Leidy Gas Field in northern Clinton County, some 32 miles to the west. Gas shows have been reported from six of the seven wells which have penetrated the Ridgeley sandstone in Waterville and Trout Run 15-minute Quadrangles. Two of these wells also reported gas shows in the Onondaga limestone or the Mahantango Formation (Hamilton Group), which overlie the Ridgeley sandstone. Vital statistics on these wells, and two others in Warrensville Quadrangle are given below in Table 1.

In addition to the indicated structural closure, there are also several non-geologic factors which tend to augment the attractiveness of this feature. The proximity of this structure to the expanding markets in the Williamsport area (some four or five miles to the south), and the presence of a major gas pipeline less than three miles from the crest of the structure should enhance the drillability of this prospect.

The author gratefully acknowledges the contribution of Rodger T. Faill and Louis Heyman of the Pennsylvania Geological Survey and Richard Howe of the Pennsylvania Department of Transportation to discussions leading to the preparation of this article. The porosity and permeability analyses were done by D. R. Reidenouer of the Soils Testing Laboratory of the Pennsylvania Department of Transportation.

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Table 1. Dry holes drilled in Waterville, Warrensville, and Trout Run Quadrangles. Wells which have penetrated the Ridgeley sandstone in Waterville, Trout Run, and Warrensville Quadrangles.

Well:	Township/ County	Location:	Elevation Total Depth	Comments & Reference
Waterville G-1 Murphy Oil & Gas #1 Springer	Gallagher, Clinton	7180′ N. of 41° 15′ 3221′ W. of 77° 25′	1749′ 8530	Gas show at 7840′ in Mahantango Fm. Fettke, 1956
Waterville G-2 Manufacturers L. & H. Co. #1 Chatham Water Works	Gallagher, Clinton	3168′ N. of 41° 15′ 5069′ W. of 77° 25′	1681′ 8576′	Gas pockets at 8240′, 8357′, in Marcellus Fm., and at 8383′ in Onondaga limestone. Fettke, 1956
Waterville G-3 Murphy Oil & Gas #1 Mohawk Rod & Gun Club	Gallagher, Clinton	106′ N. of 41° 15′ 6494′ E. of 77° 30′	1791′ 8576′	No shows reported Fettke, 1956
Waterville C-4 Felmont Oil Corp. #1 Wm. P. Day	Pine, Lycoming	1750′ N. of 41° 25′ 1500′ W. of 77° 15′	1799′	Slight gas show in Ridgeley Ss. Lytle and others, 1962
Trout Run A-1 G. L. Cabot #1 Hughes	Cogan House, Lycoming	6389′ N. of 41° 25′ 10,243′ W. of 77° 10′	1547′ 7579′	Gas shows in Mahantango Fm. and Ridgeley Ss. Fettke, 1956
Trout Run B-2 G. L. Cabot #1 Codney	Cogan House, Lycoming	9768′ N. of 41° 25′ 2640′ E. of 77° 10′	1660′ 7814′	Gas show 7607–7664′ in Ridgeley Fettke, 1956
Trout Run A-3 Felmont Oil Corp. #1 J. F. Stryker	Cogan House, Lycoming	28,350′ S. of 41° 30″; 5,400′ W. of 77° 10′	1555′ 7220′	Gas show in Ridgeley Ss; Salt water flow, Ridgeley Ss. Lytle & others, 1963
Warrensville B-1 Delta Drilling Co. #1 Ambrose Ging	Cascade, Lycoming	4594′ N. of 41° 25′ 7498′ E. of 76° 25′	1272′ 8118′	No shows reported. Fettke, 1956.
Warrensville I-2 Storey #1 Burkheart	Mill Creek, Lycoming	14,784′ N. of 41° 15′; 4435′ W. of 76° 45′	1254′ 6854′	No shows reported. Fettke, 1956.

New From the U.S. Geological Survey

USGS Miscellaneous Field Studies Map MF 685-D. *Map of zones where land use can be affected by landsliding, flooding and undermining, Allegheny County, Pa.* by R. P. Briggs and W. R. Kohl. Price: $1.00

This map portrays at a scale of 1:50,000 areas in Allegheny County where 1, 2, 3 or none of the hazards of landsliding, flooding or undermining might occur.

Slope (Clinometric) Maps of Allegheny County.

The USGS has prepared 23 experimental maps by a photomechanican process that shows the land slope in four zones—0–8%, 8-16%, 16–25%, more than 25% slope. These maps are identified by the same name and cover the same area as the standard USGS 7½-minute topographic maps covering Allegheny County. Limited copies of the slope maps are available free from the Pennsylvania Geological Survey, Room 1201, Kossman Building, 100 Forbes Avenue, Pittsburgh, Pa. 15222.

Cumberland County and Delaware County Topographic Map

A new product of the cooperative USGS-Pennsylvania Geological Survey county topographic map program. Scale 1:50,000. Shows contours at 20′ intervals, cultural features, forested areas, water and political boundaries. These, plus maps for Union, Sullivan, Forest, Montour and Jefferson counties are available at $2.00 each.

USGS cost publications are available from: Branch of Distribution, U.S. Geological Survey, 1200 S. Eads Street, Arlington, Va. 22202.

First Geologic Map of Pennsylvania Urgently Needed

If anyone knows where the Pennsylvania Geological Survey can obtain a copy or copies of the Geologic Map of Pennsylvania by H. D. Rodgers, 1842, please let us know. We will accept donations with thanks or will purchase copies. We have only one very fragile and worn copy that went through the 1972 flood. We are particularly interested in obtaining this in the original binder, if possible.

MEET THE STAFF...

Alan
R.
Geyer

In every organization there are old-timers. The Pennsylvania Geological Survey is no exception and Alan Geyer is one of them. "Al" joined the Survey during the summer of 1951 as a student assistant and in July of 1953 as a full-time staff geologist. During most of the '50's Al's field work involved the structure and stratigraphy of the carbonate rocks of the Lebanon Valley. Along with others, he was responsible for the discovery of the large Alpine-like overturned folds in the rocks of the valley. This discovery proved to be a vital "tool" in the prospecting and mining of the valuable, high-calcium limestone formation called the Annville Limestone in Eastern Pennsylvania.

In 1957 Al became the Assistant State Geologist and was responsible for those myriad of administrative duties that go along with the running of any office. The Survey was expanding rapidly during this period and in addition to the general administrative duties, purchasing, and service work, this position included the job of being the Survey editor. By 1960, however, a separate Editor's position was created. For a brief moment, from October 1961 through December 1961, Al was Acting State Geologist. Upon Dr. Socolow's appointment as State Geologist, he returned to his old duties as Assistant State Geologist.

From the time of the launching of "Sputnick" in 1957 to the present, Al has been the Survey's representative on many committees involved with the earth sciences in our society. That same year he participated in the Pennsylvania Department of Education's writing committee to create a teachers' guide to earth and space science in the secondary schools. The very next year he helped write a teachers' guide for the secondary schools on conservation for the Education Department. By this time, Pennsylvania led the nation in introducing the earth sciences to the public school system. At the close of the '50's, the National Science Foundation sponsored a national writing conference, the Duluth Conference, to create a "sourcebook" in geology and the earth sciences for secondary school teachers; Al was invited and spent the latter part of the summer of 1959 writing in Duluth, Minnesota.

With Dr. Socolow as State Geologist, he immediately was sympathetic and encouraged the Survey to become more responsive to the needs and wants of other government agencies and the general public. Thus, the Survey's Educational Series of publications was started. Al co-authored the first booklet in this series and the very popular Bulletin G-33, "Mineral Collecting in Pennsylvania." Al also played a key role in starting the highly popular Survey rock and mineral kits.

By mid-1968 a major emphasis in applied geology was sweeping the field of geology. More attention was being focused on the use of geologic knowledge to solve man's environmental problems and better plan for a quality future. In recognition of this need, the Survey created a new Environmental Geology Division. With Al's broad experience at the Survey and his interest in "applied geology" he was a natural to head up this new division.

With the start of the survey's bi-monthly publication, *Pennsylvania Geology,* Al introduced a semi-regular column in it called the "Earth Science Teachers Corner." More recently he served on the Pennsylvania Department of Education's committee to write a mini-course on the "Environmental Impact of Electrical Power Generation: Nuclear and Fossil" and update and rewrite the Department's teachers' guide to "Earth and Space Science in the Secondary Schools."

Al is a native of Lancaster County, born in Ephrata and grew up in Lancaster. He obtained a B.S. degree in geology from Franklin and Marshall College in 1951 and an M.S. (geology) degree from the University of Michigan. He is a member of several professional societies and in 1973 was presented the Ralph Digman Award by the Eastern Section of the National Association of Geology Teachers (NAGT). This award is given for "outstanding contributions on behalf of laymen-directed geology teaching." Al has authored or co-authored more than 30 published articles and geologic reports and the Survey currently has two more of his reports in press.

Al, his wife Patsy, and their two children, Ray and Beth, reside in Colonial Park, east of Harrisburg. During his off-the-job hours, Al spends his time antiquing, especially for "early" tins.

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MARCH 1976

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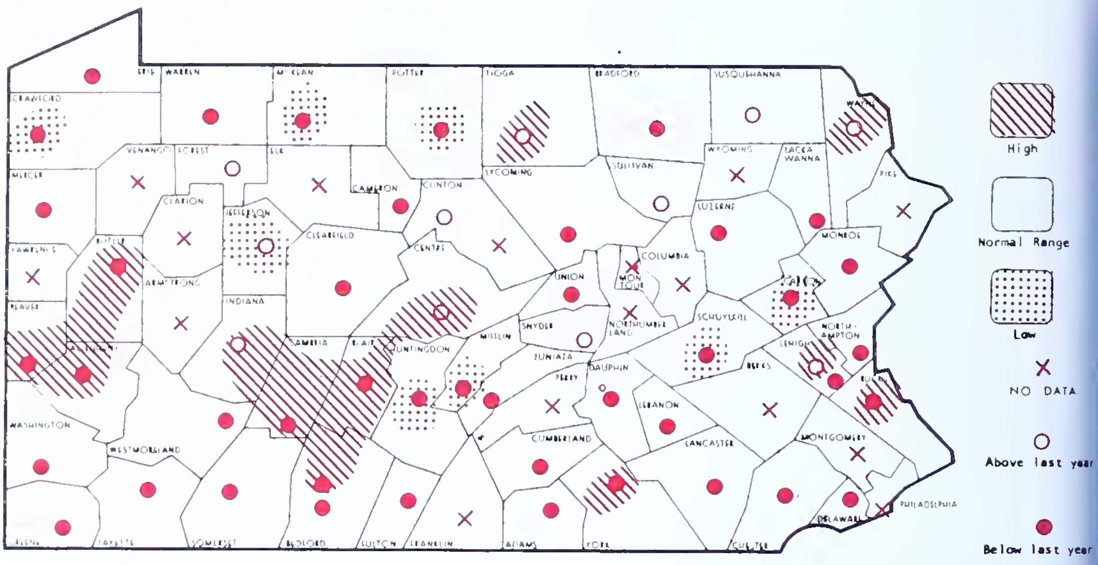

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ON THE COVER: "Dinosaur Rock", near Mt. Gretna, Lancaster County. Formed by weathering of the diabase bedrock. Photo courtesy of William Bolles.

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JUNE 1976

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

OUR CHROME-YELLOW HERITAGE

Nearly 200 years ago southeast Pennsylvania was the nation's leading chrome producer and world renowned for this unusual resource. The chromite ore producing district extended from Chester and Lancaster Counties, across the state line into Maryland, and included at least 40 recorded mining sites (Pearre & Heyl, *The History of Chromite Mining in Pennsylvania and Maryland,* Pa. Geol. Surv. I. C. 14, 1959).

Chromite, the ore mineral for chrome, was first mined in the area in 1808 and active production continued from various mines in the district until the early 1900's. It has been estimated that somewhere between 250,000 and 500,000 tons of chromite ore was produced from this area; that is a large tonnage figure for that era of non-mechanized activity and is a large figure even today for this strategic mineral. The massive chromite ore of the Wood Mine alone in southern Lancaster County, opened in 1828, supplied most of the world's chrome needs for many years; the mine finally closed in 1882.

The renowned Wood Mine and many others in the district were discovered and operated by Isaac Tyson, Jr. of the Baltimore area. In those days the great demand for chrome was to make the world-famous chrome-yellow pigment; this product was produced at the Tyson family-owned Baltimore Chrome Works from the ore mined in the Pennsylvania-Maryland district. By 1902 the chrome mines of southeast Pennsylvania were mostly worked out and ore was brought in from western and foreign sources to keep the Baltimore pigment plant going; at that point the Tyson family sold out its operations. Attempts were made to explore and mine more of the Pennsylvania-Maryland chromite occurrences during World War I and again during World War II, with essentially no success. Only a small amount of placer chromite was produced from streams in the area.

Today the United States imports essentially all of its chromite needs from such countries as Rhodesia, South Africa, Turkey, and the Soviet Union; the major use of chrome now is for steel alloys, as well as metallic chrome plating so widely utilized for esthetic and protective purposes.

All is quiet now in the Pennsylvania-Maryland chromite district, but in this Bicentennial Year it is exhilarating to revisit the old mine sites, pick at some of the leftover ore and associated exotic minerals, and reread the record of Pennsylvania's era of glory in chromite mining. It is but one of many great stories of Pennsylvania's contributions to our nation's early mineral and economic development.

Arthur A. Socolow

Our Mineral Heritage – HOPEWELL VILLAGE

by Bernard J. O'Neill

Some of Pennsylvania's mines and furnaces were already serving our country at the time of the Revolutionary War. Iron ore and limestone were two important mineral commodities that were used in charcoal-operated furnaces to make iron during those early years. The cold-blast, charcoal-fired furnace was the forerunner of America's iron and steel industry, which has contributed significantly to our present-day life style.

The Colonists were eager to manufacture their own iron for use in weapons and in shaping iron tools and household items, rather than import them at high costs. A number of iron works were established, and by the end of the 1700's, southeastern Pennsylvania was the hub of the industry. Hopewell Furnace, one of the earliest erected in Pennsylvania, was built in 1771 by Mark Bird, and supplied cannon and shot for the Continental Army. A story by old Hopewell residents tells that cannon were buried near the furnace when the British advanced up the Schuylkill Valley after the Battle of the Brandywine.

Hopewell's importance to the war effort did not go unrecognized. On June 23, 1777 the Board of War recommended that the workmen employed at Hopewell Furnace be discharged from the militia so that the armaments might continue to be manufactured there.

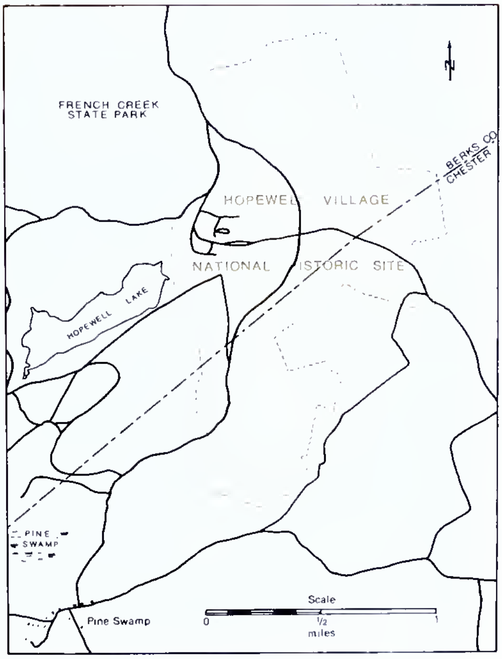
Hopewell Furnace was erected on the edge of a meadow adjacent to French Creek in Union Township, Berks County, Pennsylvania. This location offered four advantages that were meaningful to the ironmaker in the latter part of the eighteenth century. They were (1) near-surface iron ore deposits within a reasonable distance; (2) forestlands to supply a source for charcoal fuel; (3) a fast-flowing stream to generate energy for the blast bellows at the furnace, and (4) an adequate local supply of limestone for use as a flux in the operation.

Iron ore for Hopewell Furnace was furnished from three mines. The earliest source of ore came from the Hopewell Iron Mine which first operated about 1770. It is located about 1¼ miles west of Warwick, on the east side of Thomas Hill in Warwick Township, Chester County, and is approximately 3.5 miles by present-day roads from the furnace. The ore occurred in two veins, each about 7 feet thick near the surface, but widening to as much as 25 feet at depth. An analysis of the ore in 1883 showed it to contain almost 38 percent iron.

Hopewell Village furnace and cast house. National Historic Site. Photo courtesy of National Park Service, U. S. Department of Interior, Richard Frear, photographer.

The Jones Mine, located east-southeast of Joanna in Caernarvon Township, Berks County, Pennsylvania, was another early source of iron ore for the Hopewell Furnace. A water-filled excavation which represents the former quarry site is identified as Jones Millpond today.

The Warwick Mine, located near St. Mary's Episcopal Church in Warwick Township, Chester County, Pennsylvania, was the third source of iron ore. This mine was opened before 1760, but records indicate it did not supply iron ore to Hopewell until 1821. This mine consisted of



numerous veins ranging in thickness from 1 to 17 feet; the ore was of good grade, averaging about 45 percent iron.

The early mining for iron ore for the Hopewell Furnace was by open pit and bell pit mining with safety factors controlling the depth to which each mining operation could go. Usually, one man in the open pit pried the ore loose and placed it in a bucket or basket. A second man on the surface pulled the load up on a rope. After the ore came to the surface, it was washed in a sluice to separate out waste soil. Miners were penalized for contaminated ore at the furnace. In the 1780's, one two-man team of miners supplied the needs for Hopewell Furnace. In the early 1800's, this number had increased to 7 full-time and several part-time miners. Wages paid to a miner in the years 1805 to 1807 ranged from $12 to $15 per month. Living costs at that time, however, were vastly different from today. For example, the rental charged for a good house was about $10 per year in the early 1800's.

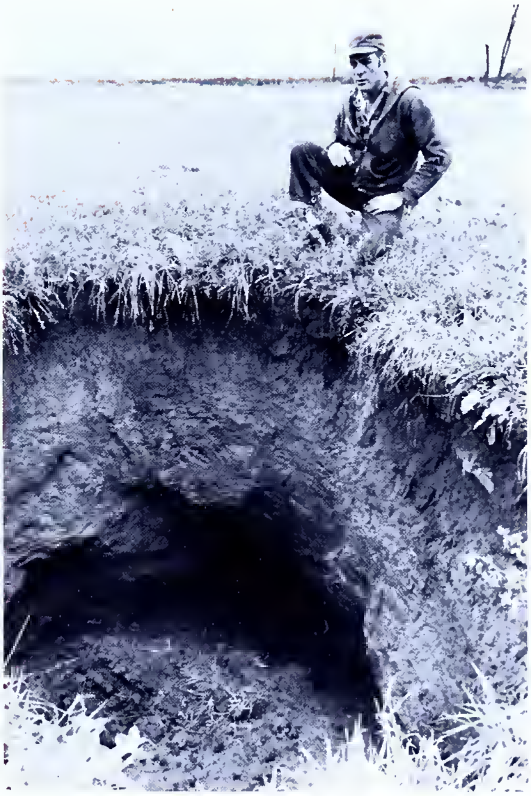
Limestone for flux was obtained from local quarries in Hopewell or brought in from sources located east of Morgantown. A typical half-hour charge to the furnace in the early 1880's was reported to be as follows: 15 bushels of charcoal, 400 to 500 pounds of ore, and 30 to 40 pounds of limestone. In normal operations it took about 160 bushels of charcoal to make a ton of iron, and the annual requirements for charcoal demanded 5,000 to 6,000 cords of wood.

The oldest known product from Hopewell Furnace is a stove owned by the Birdsboro Y.M.C.A. identifying the Furnace and the date 1772. In 1844, stove-casting at Hopewell was essentially discontinued due to severe competition from coal-operated furnaces. The latter had the distinct advantage of reduced labor costs and many large coal-operated furnaces were built in urban centers where better transportation facilities prevailed. Hopewell Furnace continued to produce pig iron from 1844 to 1883 only because the expansion of railroads and the Civil War had created a high demand for iron. Because the pig iron produced had limited uses, such as utensils, much of it was shipped to forges (such as Valley Forge) to be made into the tougher and less brittle wrought iron. This was used to make tools, hardware, and horseshoes. The reprieve for Hopewell lasted until 1883, at which time its last blast came.

Hopewell Furnace and the iron ore mines and limestone quarries that helped feed it for so many years may indeed appear insignificant to the iron and steel operations of 1976. But let us not forget that they, together with the many other small operations in the mineral industries gave us the direction we needed to reach our bicentennial anniversary.

Hopewell Furnace, together with other buildings, has been restored to its appearance of 1820-1840. Known as the Hopewell Village National Historic Site, it is administered by the National Park Service, U. S. Department of the Interior. Hopewell Village is located 5 miles south of Birdsboro, in Union Township, Berks County, Pennsylvania, about 10 miles from the Morgantown Interchange of the Pennsylvania Turnpike. The site is open from 9 a.m. to 6 p.m. daily, July 1 through Labor Day. During the rest of the year it is open from 9 a.m. to 5 p.m. daily, except Christmas and New Year's Day. Inquiries and communications regarding the site should be addressed to the Superintendent, R.D.#1, Box 345, Elverson, Pa. 19520, or phone (215) 582-8773.

Another Pennsylvania Sinkhole



As the subject of limestones, sinkholes, and solution cavities becomes familiar to more of our citizens, we find that more and more of these features are being recognized in various parts of Pennsylvania. We appreciate the cooperation of the Milton Standard in sharing the above photo of Donald Gush observing an eight-foot-deep sinkhole which recently developed on the Walter Gush farm near Dewart.

TRIASSIC-JURASSIC DIABASE EXTENDED

by
D. M. Hoskins

New mapping in the Halifax, Millersburg and Elizabethville 7½-minute quadrangles north of Harrisburg reveals that Triassic-Jurassic diabases that traverse South Mountain, the Great Valley, and the Valley and Ridge province from Gettysburg to just beyond the Juniata River, near its confluence with the Susquehanna River, actually extend northward about 15 miles further than had been previously known.

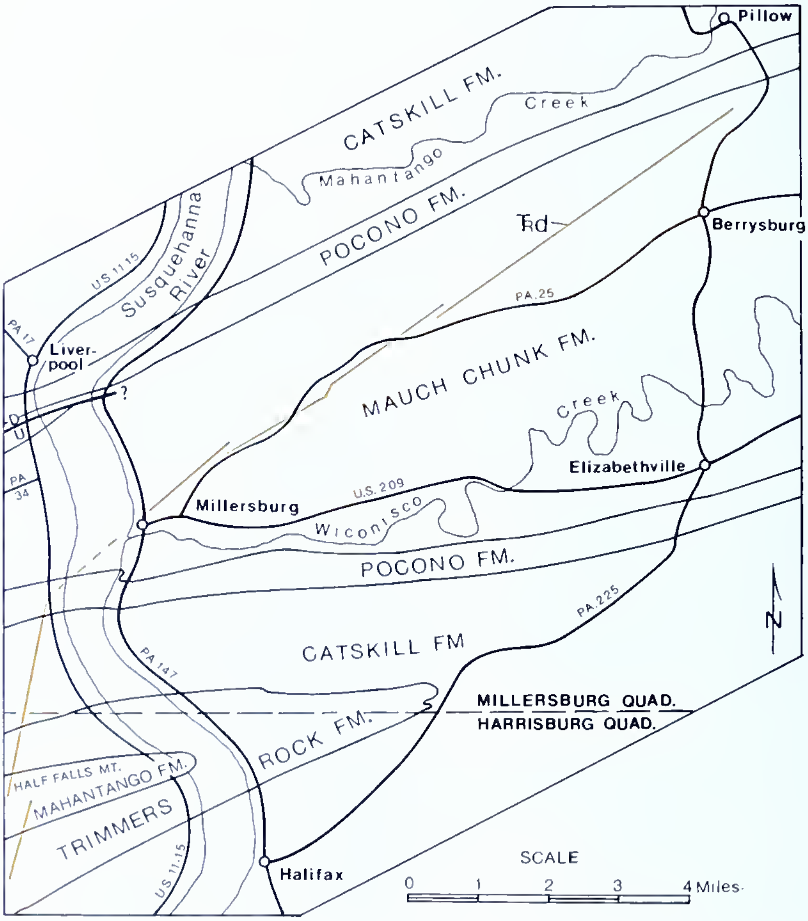


Figure 1. Geologic map of portions of the Millersburg and Harrisburg 15′ quadrangles.

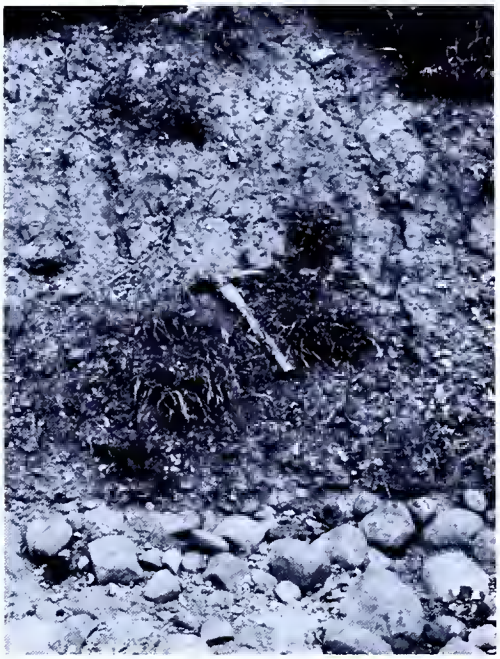


Figure 2. Weathered diabase cobbles in place in recently excavated housing development road in Borough of Millersburg.

The discovery was made at a new exposure in a housing development in Millersburg (Figure 1). Mapping was conducted primarily by use of a back-pack magnetometer because the diabase is very thin and forms no topographic expression. Only a few rounded cobbles of the diabase normally occur at the surface to show its location. One complete exposure was found behind the retaining wall (Figure 2) along U.S. 11-15, just south of Mt. Patrick in the gap cut by the Susquehanna River. Here the diabase may be seen in relatively fresh exposure where it is 11 feet thick. The diabase is highly fractured allowing easy erosion and it forms a gully on the cut slope that is a source of rock falls, thus necessitating the retaining wall. The diabase is uniformly dark gray and weathers to a characteristic orangish-red.

This diabase is a continuation of the dike ("Ironstone" Ridge) that extends northward from Gettysburg and forms a low ridge above the carbonates of the Great Valley Province. Henry D. Rodgers described this dike in 1842 in the publication "Geology of Pennsylvania" (p. 366). He noted that the diabase crossed Half Falls Mountain and extended into Lykens Valley, but his map shows its position to the east of its actual position where it crosses the Susquehanna. Rodgers did not show any trace of the dike in Lykens Valley although his report indicates he knew of its presence there. Geologic maps of the Commonwealth published since that date showed the dike extending to Half Falls Mountain but not beyond. Possibly the misplotting of the very thin dike on the 1842 map and difficulty of tracing led later compilers to doubt its existence north of Half Falls Mountain. The latest mapping, however, has corroborated the observations of Henry Rodgers in 1842.

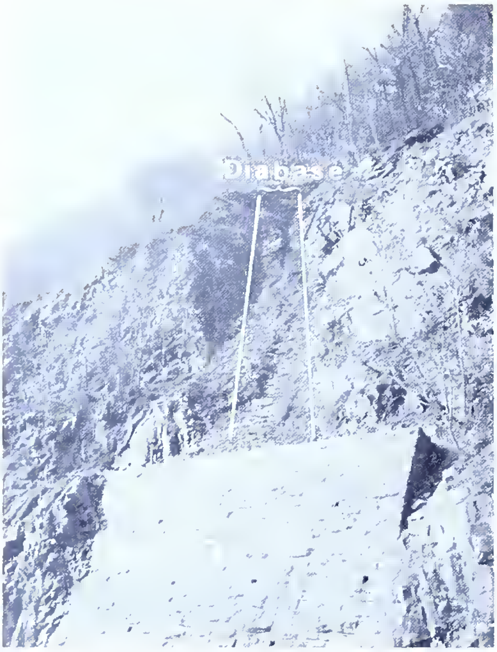


Figure 3. Complete exposure of diabase in road cut on U.S. 11-15.

An anomalous feature of the dike is the change in strike from 016 degrees to 054 degrees after crossing the Susquehanna. The 054 degree direction parallels a linear feature observed in a Landsat-1 image of the area.

It is assumed that the dike is emplaced along a fracture of a regional set.

A Landslide . . .

of rocks over Route 994 along the recently completed Raystown Lake. The failure occurred along bedding planes inclined toward the roadway as a result of weakening by construction blasting, freezing and thawing ice, followed by the pull of gravity on the steep cut. Aided by weathering of shales to form slippery clay, the sandstone and siltstone beds then slid down the slope onto the road. Photo taken 2/12/76 by E. Hess.

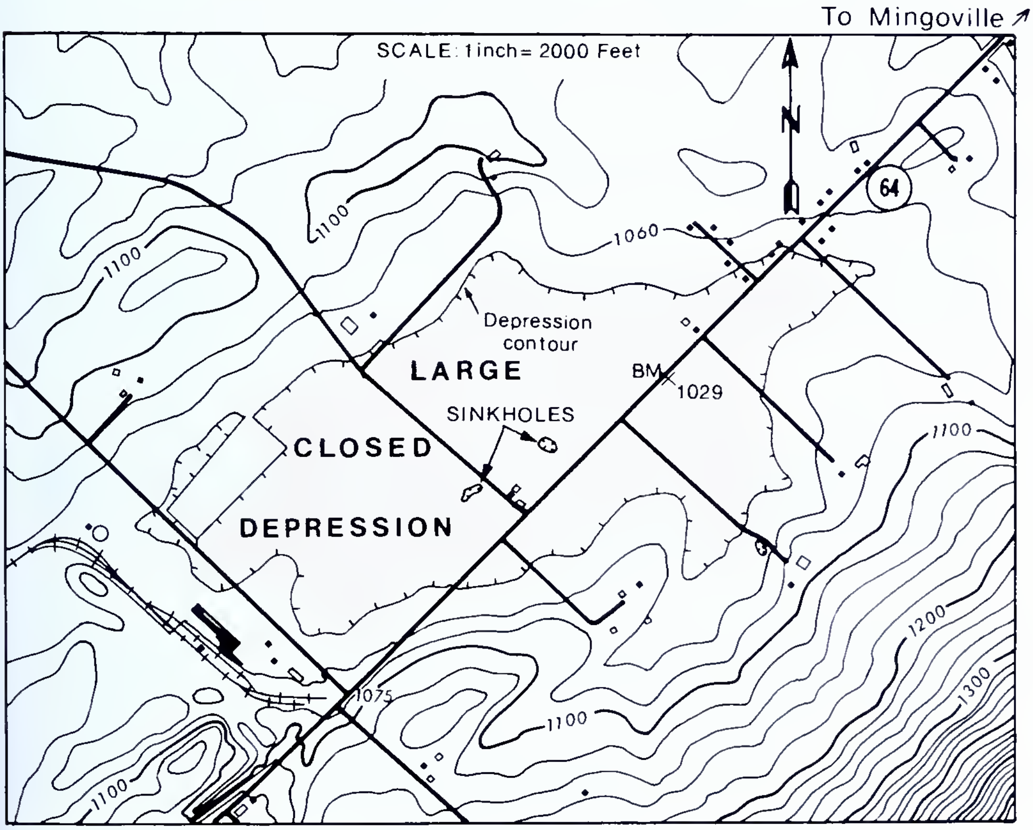
The Phantom

by John P. Wilshusen

There is much written in newspapers and magazines today about a monster in a Scottish lake, about Yeti, the Abominable Snowman, and fierce white sharks devouring unsuspecting humans. No such mysterious creature has yet been reported in Pennsylvania, but a mysterious lake has.

This lake, in Centre County, is called Phantom Lake. It comes and goes with no stream entering into it, nor one exiting from it. At times a large lake is formed, at other times a small one. The largest was about 15 feet deep and covered an area of more than 200 acres, flooding Pennsylvania Route 64 to a depth of about 4 feet. Recent levels, however, have been affected by pumping in a nearby quarry.

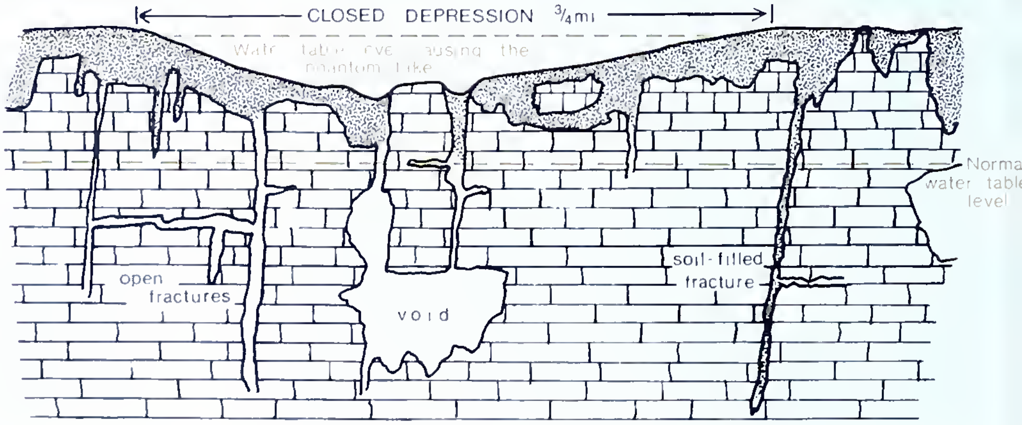
The Phantom had not been seen for a number of years prior to Hurricane Agnes in 1972. But, that year, and for almost every year since, the lake has appeared and disappeared, keeping no predictable schedule with the seasons and staying for up to six weeks. Maintaining



its mystery, for example, it remained dry after heavy rain associated with Hurricane Eloise in September 1975. Reportedly, the appearance or disappearance of the lake is not directly related to rainfall at the time. It seems, almost, that a legend could be written about an army of ghostly giants who, like the *Sorcerer's Apprentice* with his magic broom, carry large quantities of water going to and fro, filling and emptying their pails.

Although unusual in Pennsylvania, Phantom Lake is not a real mystery. Its occurrence can be explained. The sketch map, with a contour interval of 20 feet, shows a large, closed topographic depression at the foot of Nittany Mountain. Near the bottom of the depression there are a number of small sinkholes connected with solution channels in limestone bedrock below. There are many channels along fractures, varying in width from less than an inch to perhaps a foot or more. These openings contain varying amounts of clay and silt which in some cases block the channels. The channels become narrower with increasing depth and water flow in them is more restricted than at shallow depths. The fractures are a reservoir for ground water, serving as the source of water for drilled wells.

The surface of this underground supply is called the water table. The water table isn't always at the same elevation; it comes closer to the surface after periods of wet weather and drops farther below the surface after periods of dry weather. Although analogous in many respects to the surface of a body of water that we can see, the water table differs in that its progress up or down may be blocked locally by mud and silt filling some fractures, or by interruptions in the fracture system. During a rise, a portion of bedrock may be left unsaturated with water rising all around. During a drop, another portion of bedrock may not drain leaving a perched water table. The same thing



doesn't always happen at a given locality during each change in water table elevation because a previously blocked fracture may be washed out or another one filled in.

The lakebed of Phantom Lake is an abnormally low area on the land surface; a "window" through which we can look at the water table when it is high. Water rises through bedrock channels into sinkholes which overflow into the lakebed (See sketch). When the water table goes down the lake disappears, draining out through the sinkholes.

Most kinds of bedrock contain fractures through which ground water flows. Limestone however, is different from the others in that it is slightly soluble in percolating ground water. This solubility is the key that makes the difference and allows the formation of topographic depressions, sinkholes and irregular underground channels and openings.

With such a background, is it possible for Phantom Lake to come some day and stay? Possible, but not probable.

New Research Center for Zinc Company

The New Jersey Zinc Co. has announced plans to build a $3-million research center on a 19-acre site just east of the Holiday Inn East, near Bethlehem. The new facility will be known as the Harold U. Zerbe Research Center in honor of NJZ's former chairman of the board.

The research center will be completed next year and it will permit consolidation of the company's research and development programs, now conducted at several locations in Palmerton, under one roof for more efficient operation.

NJZ will move its analytical research and administrative offices and its applied research laboratory from Palmerton to the new site, retaining only the field station near the East Plant in Palmerton as a pilot plant for development. Such projects as ore evaluation, hydrometallurgy, extractive metallurgy, chemical process technology and others will be carried out at the new center.

Oil Spoiled the Salt

by Virginia Lytle

The earliest recorded petroleum discovery in Butler County was in 1810 when the well that was dug to increase the supply of salt water at Kearns Crossing produced oil as well as salt water. The salt manufactured there was used for many years, although eventually the oil did spoil the taste of the salt. But all was not lost. The oil was collected, bottled and sold as a medicine for rheumatism, bruises and toothache.

The Kearns Crossing well was dug fifty years before Drake's famous Titusville discovery. Drake drilled for oil and got oil, and the event has been recorded as the beginning of the petroleum industry.

But the drilling of Drake's well was not the beginning of oil history. Oil had been percolating out of crevices in the earth's crust for thousands of years. Oil history goes back to Genesis. "Make thee an ark of gopher wood . . . and pitch it within and without with pitch," God said to Noah. (Gen. 6:14) "Will Jehovah be pleased with . . . ten thousands of rivers of oil?" asked Micah, near the end of the Old Testament. (Micah 6:7)

Petroleum was known to the ancient Romans as "bitumen." It has been used by the people of Asia, Africa and Europe for thousands of years. In Sicily the ancient inhabitants burned petroleum in their lamps. Petroleum was used for nearly two centuries before Drake for lighting the streets of Genoa and Parma in northern Italy.

The earliest reference to oil in America is credited to Joseph de la d'Allion, a Franciscan missionary who crossed the Niagara River from Canada in 1629 and wrote that in Cuba, New York, there was oil that the Indians called "antonontons," which meant "plenty there."

The early pioneers learned of the medicinal uses of "Seneca Oil" from the Indians.

Along Oil Creek between Titusville and Oil City, and in other western Pennsylvania locations, are pits, described by John F. Carll in 1886, cribbed with timber, the work of early Indians or earlier inhabitants, dug for the purpose of collecting petroleum. The pits belonged to a people who had free range of the country and were familiar with every spring, ravine and stream in the area, for in every place where it was possible to obtain surface oil, these pits were found. A great deal of oil must have been collected. What became of it? Who dug the pits? The mystery has never been solved. Trees found growing in the pits in 1815 were so old that they had been growing since before any white man visited the area. Indians and early white settlers gathered oil from these pits by spreading blankets over the surface and squeezing out the oil that had soaked into them.

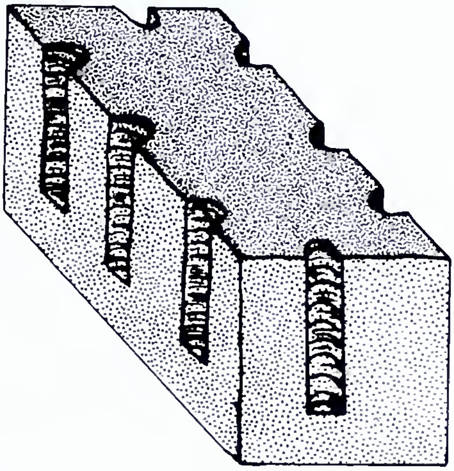
Two oil seeps along Slippery Rock Creek were known to the early settlers. One was near the present Glasser Bridge and the other was two miles further upstream, just below the mouth of Hell Hollow. These seeps are no longer active.

When oil was being collected from the salt well at Kearns Crossing in 1810, "Uncle Billy" Smith, future driller of Drake's well, was not yet born. He would be born in 1812 on a farm at Hubb Run in Butler County (presumably near Kearns Crossing). Butler County was destined to provide links in the chain of oil history. But let's wait for Uncle Billy.

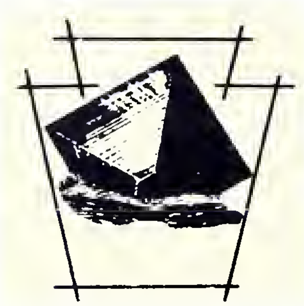
The Lighter Side of Our Service

Of all the requests we received and answered over the last twenty years, one particular case stands out. In the late 50's there were fewer geologists with the Bureau then at present and fortunately there were fewer demands on each person's time. When a request came in, a personal visit was made, if at all possible. Such as the setting when one afternoon a young housewife called and asked us if we could come out to her house immediately. She seemed quite upset and her second question was, "are there any kind of worms that eat sand?" She went on to tell us that she lived in a home built of sandstone and that every time she looked at the stone on her house she noticed more and more holes in the rock. According to her these were not small holes but were up to one inch in diameter and appeared to be more numerous each day.

After assuring the young lady that there were no worms that would or could eat sandstone, we told her that we would visit within the hour. Dr. Lapham, our mineralogist at that time, and I drove to her home in north Harrisburg and immediately began to inspect a very beautiful sandstone structure. In a few minutes we discovered her dilemma. When some stone cutters prepare dimension stone in small block sizes and



when some quarry operators attempt to quarry rectangular blocks of dimension stone, they drill (by hand or by machine) small one-inch diameter holes into the stone every four to six inches apart until it splits or until they know they can split it easily. These drilled holes never go completely through the face of the split and are never meant to detract from the appearance of the rough stone face. Some stone blocks only have one hole whereas others may have as many as four in them. The stone mason when he builds the house will try to alternate these and the overall effect is usually one where the home owner will never see them. However, this young woman did and every time she looked she thought she saw more. In fact, so many that she was worried that something lived in there and was eating the stone. When we left, we felt sure we convinced her of the nature of these very regular, half-round tubes.



EARTH SCIENCE TEACHERS' CORNER

new leaflets from the u.s.g.s.

"Types of Maps—Published by Government Agencies", 8 pages.
Selected types of maps and charts published by government agencies are listed; addresses of publishing and agencies are also listed.

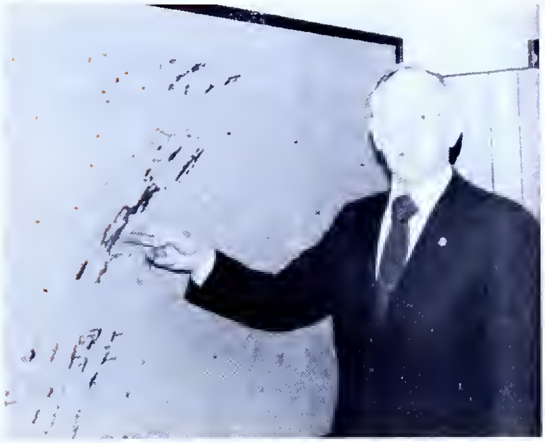
"New Activities at the U. S. Geological Survey", 12 pages.
The U. S. Geological Survey focuses its work on some of the Nation's most critical problems. This pamphlet describes how the Survey tackles these new problems with new techniques, and explains the awareness of the resource needs and environmental pressures of an expanding economy and growing population.

b.e.s.t. earth science teacher award

Each year the National Association of Geology Teachers recognizes the most outstanding earth science teacher in the secondary schools in each state of the Nation. Pennsylvania's winner this year is JOHN WALTER RESSLER from Greencastle-Antrim High School in Greencastle, Franklin County. Mr. Ressler will be honored at the Eastern Section's annual meeting in Saratoga Springs, New York, and at the annual meeting of the National Science Teachers Association in Philadelphia.

MEET THE STAFF...

William S. Lytle,
Chief, Oil and Gas
Geology Division



Bill joined the staff of the Pennsylvania Geologist Survey as a junior geologist in 1940, after working during the summers with the Survey while attending Penn State University. He went on active duty with the U. S. Army Corps of Engineers in 1941 and after five years in the service, returned to the Survey staff. Bill has held the positions of Senior Research Geologist, Assistant State Geologist in charge of oil and gas, and is currently Chief of the Oil and Gas Geology Division.

Bill has spent his entire career working in the oil and gas fields in the western part of the Commonwealth. He worked out of the Pleasantville, Titusville, Oil City and Butler field offices and has been in the Pittsburgh office since 1957. He has authored 9 Survey publications, and has been co-author of 28 other reports. Bill has written over 100 articles that have been published in governmental publications, petroleum industry journals and books and he has talked to many industrial organizations on Pennsylvania's oil and gas industry. He is a member of numerous professional societies and is currently a section chairman for the American Petroleum Institute committee on statistical drilling and a respondent for the Institute; he is coordinator and author for the American Association of Petroleum Geologists District 20 annual development publication, author for the International Oil Scouts, a member of the National Executive Reservist for Oil and Gas, and holds positions in several other organizations.

Bill was born in Pleasantville, Pennsylvania, a third generation oil man; he obtained his B.S. degree in Petroleum and Natural Gas

Engineering from Penn State University and additional credits in Geology from the University of Pittsburgh. In addition to his work in the oil and gas fields, he has always been interested in groundwater work. While with the Survey, he has helped scores of individuals, companies, and organizations find fresh water for their needs. He has frequently provided geologic assistance to school groups, scout jamborees, and various service organizations. He also continued his interest in the Army Reserves—Corps of Engineers, recently retiring a full Colonel.

Bill lives outside of Butler in Meridian with his wife, Virginia, and daughter, Jill. Three older children have graduated from college and are working along the east coast. Bill has always lived in the oil belt and Meridian is no exception. From his front porch, he can look across the fields and see the location of the famous Spotty McBride well. And on the way to work every day, he passes the location of the third largest oil producer in the State, the 10,000 barrel Armstrong No. 2. Currently being exploited in the Titusville area is an oil sand called the Lytle sand that was named after his grandfather.

FIELD CONFERENCE THANKS DONATORS OF GUIDEBOOKS

In response to our call for original copies of Field Conference Guidebooks (Pennsylvania Geology, vol. 6, no. 6, December 1975, p. 11), we received an original copy of the Fifth Field Conference from John Wells of Cornell, a facsimile copy of the 12th Field Conference from E. F. Koppe of Harrisburg, and original copies of the 12th, 13th and 15th Field Conferences from Albert I. Ingham of Consolidated Natural Gas Service Company.

Our grateful thanks go to each donator.

Ask The Survey

It is true that we answer hundreds of questions each month but sometimes they stump us. The other day a gentlemen called representing a Pennsylvania school and its natural-area project. He was told that we could supply him with seedlings of the tree George Washington planted. He apologized for not being able to tell us the scientific name of the tree nor its location; though that wouldn't have had any bearing on our answer anyway. Needless to say, we couldn't supply the seedlings.

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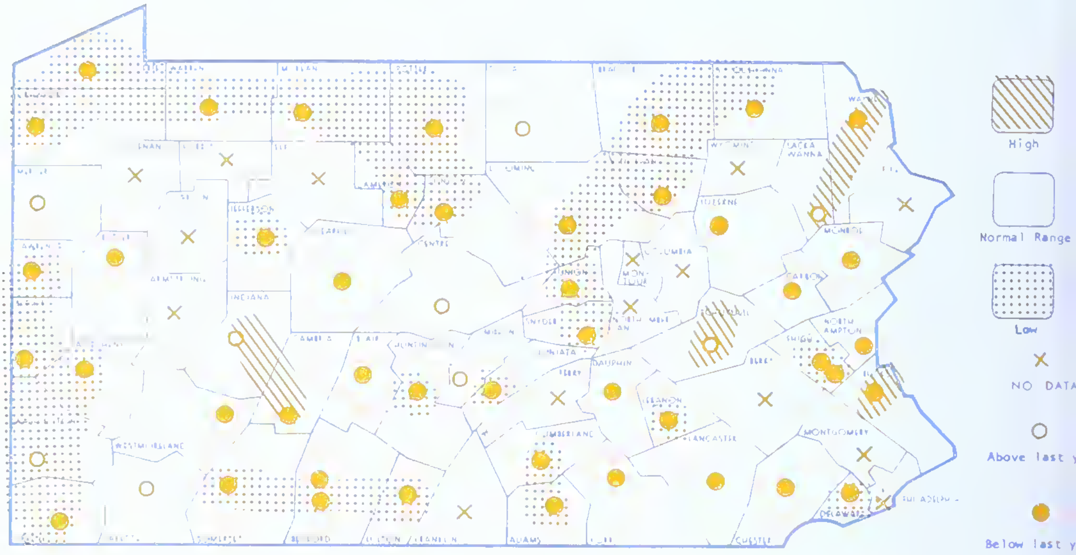

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ON THE COVER: View at Harrisburg looking south along the Susquehanna River during one of its more peaceful moments. Photo courtesy of Grant Heilman, Lititz, Pa.

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AUGUST 1976

FROM THE DESK OF THE STATE GEOLOGIST...

LEAD AND ZINC, MUCH IN THE PAST, MORE IN THE FUTURE

Today Pennsylvania has no lead mining and only one operating zinc mine, located in Lehigh County, at Friedensville, just south of Bethlehem. But it was not always so. More than 40 mines have produced lead and zinc in Pennsylvania during the past 200 years and there were times when more than a score of zinc-lead mines were operating concurrently and the Commonwealth was recognized as one of the nation's leading zinc-producing states.

It all began in 1778 with some shallow zinc-lead mines in the Sinking Valley of Blair County. The ores were actually used to support the Revolutionary War operations with the lead content sought for bullet making. Several mines in that first area operated on and off until about 1900, with attention in later years focused more on the zinc content rather than the lead. The history of Sinking Valley zinc-lead production includes such mine names as Albright, Keystone, Fleck, Bridenburgh, and Isett.

In Bucks County the history of the New Galena mine is reputed to go back to the days of George Washington's Valley Forge encampment, with the major production in the 1860's.

The Chester and Montgomery County area, centered on the town of Phoenixville, has a rich and extensive history of zinc prospecting and production, with a long list of well known mines, including the Wheatley, Phoenix, Pennypacker, Perkiomen, Buckwalter, Ecton, Napoleon, Charlestown, and Brookdale Mines. Mining was well underway by 1809 and continued until nearly 1870; in 1917 the mines were reopened and some high grade ore was produced.

Columbia County made its contribution to our mining record with a report of lead mining in 1816 at Webb's mine, some 24 miles from Northumberland.

Lead and zinc mining in Lancaster County goes back well over a 100 years with the famous Pequea Mine (north of Marticville) and Bamford Mine providing a record of extensive production of zinc, a small amount of lead, and even by-product silver. Bamford production supported a large furnace and chemical operation at the site.

In terms of size of mines, volume, and value of production, the zinc mines of Lehigh County rank foremost. Located in Saucon Valley, just south of Bethlehem, the list of mines includes such names as Ueberroth, Old Hartman, New Hartman, Correll, and Triangle. Starting with open-surface mining in the early 1800's and then by deep-shaft mining, the ores were processed through large mills and furnaces. Since the mid-1950's the sole operator there has been the New Jersey Zinc Company which has developed a modern, integrated mining and milling operation. That one mine places Pennsylvania in the ranks of the country's major zinc producers.

(Continued on page 32)

GEOLOGICAL RESEARCH IN PENNSYLVANIA
1976

INTRODUCTION

This publication is the nineteenth annual report on Geological Research and Publications in Pennsylvania. This is an attempt to list all current geologic research in Pennsylvania and includes persons and projects other than those of the Pennsylvania Geological Survey. Because of the extensive response and large number of projects reported to us, we have had to exercise editorial license to reduce the description of the research projects to fit our available space. We have also attempted to determine an anticipated completion date (ACD) for each project. The anticipated completion date is the estimate of the date when the author will complete his report; additional time for publication should be projected.

The listings are grouped into major categories of research to facilitate your search for information on a particular subject. Publications in press are listed by author.

As with all compilations, there may be omissions; this is unintentional. Additional copies of this report may be obtained by writing to the Bureau of Topographic and Geologic Survey, Department of Environmental Resources, Harrisburg, Pennsylvania 17120.

RESEARCH IN PROGRESS

AREAL GEOLOGY

T. M. BERG, A. A. SOCOLOW, D. M. HOSKINS, A. R. GEYER, S. I. ROOT, A. D. GLOVER, W. E. EDMUNDS, and W. D. SEVON, Pa. Geol. Survey. Revision of Pennsylvania State Geologic Map. Approximately one-third of the commonwealth has been compiled. Includes new and revised detailed geologic mapping accomplished since 1960. Remaining areas of the state are being revised by extrapolation and reconnaissance. It is expected that the 1:125,000 working revision will be completed by Fall 1976; final publication will be at the customary 1:250,000 scale. ACD: Mid-1977.

M. J. BERGIN, U. S. Geol. Survey. Geology of the Northern Anthracite Field, Pa.

M. R. CANICH, The Pa. State Univ. Structural Analysis of the Tyrone-Mt. Union Lineament. The study of the general nature of the transgressive morphological differences between Tyrone and Petersburg by combining field observations with data from Landsat images and U-2 and low altitude photographs. ACD: Sept. 1976.

WILLIAM CROWLEY, Md. Geol. Survey. The Geology of Carroll Co., Md. On the basis of both stratigraphic and structural evidence I have traced George Fisher's Wakefield Valley syncline northeastward to the Mason-Dixon Line. Examination of available high altitude imagery suggests that the syncline can be further traced at least to the Susquehanna River. I think this structure may turn out to be a major element in the crustal architecture of the Piedmont.

WILLIAM CROWLEY, Md. Geol. Survey. The Geology of the Eastern Maryland Piedmont. On the basis of mapping in Md.'s eastern Piedmont I think there is substantial evidence that the Baltimore Mafic Complex (Baltimore Gabbro) is allochthonous.

A. A. DRAKE, JR., U. S. Geol. Survey. Allentown Quadrangle and Vicinity. Project temporarily recessed.

J. B. EPSTEIN, U. S. Geol. Survey. Wind Gap and Adjacent Quads. Continue map and report preparation and field work in the Saylorsburg quadrangle. ACD: 1977.

J. L. FAUTH,, SUNY at Cortland. Geology of the Iron Springs Quad. Area, South Mountain, Pa. ACD: Sept. 1976.

G. W. FISHER, Johns Hopkins Univ., and M. W. HIGGINS and I. ZIETZ, U. S. Geol. Survey. Aeromagnetic Interpretation of Northern Piedmont [Piedmont and Blue Ridge of Pa., Md., and Va.]. Regional interpretation of Piedmont structure and stratigraphy, based on reconnaissance mapping, aeromagnetic maps, and detailed mapping of selected areas. ACD: 1976.

A. D. GLOVER, J. H. WAY, JR., and R. T. FAILL, Pa. Geol. Survey. Geology and Mineral Resources of the Altoona 15′ Quad., Blair and Cambria Cos., Pa. ACD: 1977.

J. D. INNERS, Pa. Geol. Survey. Geology and Mineral Resources of the Berwick Quad., Columbia Co., Pa. ACD: 1977.

S. I. ROOT, Pa. Geol. Survey, and A. E. BECHER and W. WETERHILL, U. S. Geol. Survey. Hydrogeology of Cambro-Ordovician of the Great Valley, Cumberland Co. Bedrock mapping of Cambro-Ordovician sedimentary rocks in Cumberland Co. ACD: 1976.

H. W. SCHASSE, Dunn Geoscience Corp., and A. W. ROSE, The Pa. State Univ. Geology of Jacks Mountain within Butler Knob and Mt. Union, Pa. 7½′ Quads. Geologic map and cross sections of the crestal portions of Jacks Mountain (southern extension of Kishacoquillas anticlinorium) within Huntingdon and Mifflin Cos., Pa. Includes a structural study of the anticline and a study of base-metal sulfide vein orientations and their possible relationship to local structures. ACD: July 1976.

W. D. SEVON, Pa. Geol. Survey. Surficial Geologic Map of Pennsylvania at 1:1,000,000 Scale. ACD: Sept. 1976.

W. D. SEVON and T. M. BERG, Pa. Geol. Survey, and L. D. SCHULTZ, Gilbert Assoc. Geology and Mineral Resources of Pike Co., Pa. ACD: 1977.

R. B. WELLS, Pa. Geol. Survey. Geology and Mineral Resources of Montoursville North and Huntersville Quads., Lycoming Co., Pa. Geologic mapping of Devonian through Mississippian sedimentary rocks, with a description of the structure, stratigraphy, economic geology, geomorphology, and engineering characteristics of each formation. ACD: Dec. 1976.

G. H. WOOD, JR., U. S. Geol. Survey. Geology and Coal Resources of the Southern Anthracite Field [1500+ sq. mi.]. Project objective is to map the complete geology of the Southern Anthracite field.

ECONOMIC GEOLOGY

J. M. DENNISON, Univ. of N. C. Uranium Favorability of Nonmarine and Marginal Marine Strata of Late Precambrian and Paleozoic Age in Ohio, Pa., N. J., and N.Y. ACD: Late 1976.

WALLACE DE WITT, JR., U. S. Geol. Survey. Appalachian Basin Oil and Gas Resources. Although the basic synthesis of oil and gas data for Paleozoic rocks and a deep-well map showing location of recent tests for oil and gas in the Appalachian Basin have been compiled and published, work will continue in collection of data on geometry, structure, and gas potential of Devonian black shales in the Appalachian Basin until project is terminated in June. ACD: June 1976.

A. F. JACOB, U. S. Geol. Survey. Basin Analysis of Uranium-Bearing Paleozoic Rocks of Eastern U. S. Reconnaissance of Paleozoic delta systems in central and southern Appalachian Basin and compilation of a map of uranium occurrences in Paleozoic sedimentary rocks of the Appalachian Basin. Work will then begin on the depositional systems, stratigraphy, and petrology of a selected Paleozoic delta system. ACD: 1980.

W. S. LYTLE and LAJOS BALOGH, Pa. Geol. Survey. Oil and Gas Field Map of Pa. The 1963 map showing the locations of the oil and gas pools and fields will be brought up to date as of June 1, 1976. ACD: 1976.

W. S. LYTLE, Pa. Geol. Survey, and petroleum engineers with the major oil operators in Pa. Description of the Oil Fields in Pa. and Their Reserves. Recomputing the crude oil reserves on the basis of additional data and better understanding of the reservoirs. ACD: 1976.

B. J. O'NEILL, JR., and J. H. BARNES, Pa. Geol. Survey, and K. J. LILES, U. S. Bur. Mines. Properties and Uses of Pa. Shales and Clays, Southwestern Pa. Continuation of the series of programmed studies to evaluate the economic potential of clay-shale raw materials for ceramic and non-ceramic uses. ACD: Jan. 1977.

B. J. O'NEILL, JR., and Geologic Mapping Division, Pa. Geol. Survey, and U. S. Bur. Mines. Investigations for High-Calcium Limestones in Pa. Objectives are: (1) to sample and analyze limestone units where information is lacking, incomplete, or widely scattered; (2) to map any newly discovered high-calcium limestone unit that has a potential for commercial extraction; and (3) to synthesize the data into publications which will be useful guides to exploration targets.

QUAKER STATE OIL REFINING CORP. Secondary Oil Recovery, Bradford Second Sandstone [McKean County].

A. W. ROSE, R. L. SCHMIERMUND, and DENNIS MAHAR, The Pa. State Univ. Geology and Geochemistry of Uranium Occurrences near Penn Haven Junction, Carbon Co., and Beaver Lake, Lycoming and Sullivan Cos., Pa. The geology of the deposits and their surroundings has been mapped and the geological and geochemical controls for mineralization are being studied. In addition, the geochemical behavior of uranium and its mode of occurrence are being investigated. ACD: Sept. 1976.

A. W. ROSE and SCOTT TREGASKIS, The Pa. State Univ. Geology and Mineral Occurrences of the Morrison Cove Area, Bedford Co., Pa. ACD: June 1977.

R. C. SMITH, II, Pa. Geol. Survey. Zinc-Lead Occurrences in Pa. The report covering the location and geology of all known zinc and/or lead occurrences in Pa. is in preparation. Following publication, pure mineral separates will be analyzed for selected elements. These data will be interpreted for economic by-product, pathfinder, genetic, and environmental implications.

C. E. TURNER, U. S. Geol. Survey. Basin Analysis as Related to Uranium Potential in Triassic Sedimentary Rocks, Eastern U. S. Preparation of location map for uranium occurrences in Triassic rocks, and field work in Newark-Gettysburg Basin. Environmental interpretations of Stockton, Lockatong, and Brunswick Formations, and study to determine mineralogy of uranium sandstones and shales from Newark-Gettysburg Basin will then begin. ACD: 1977.

ENGINEERING GEOLOGY

J. A. CICIARELLI, The Pa. State Univ. Surface Reduction Rates of Carbonate Dimension Stone in Urban-Industrial Atmospheres of Southwestern Pa. 500 marble headstones in 50 cemeteries in Allegheny Co. have been examined. Solutioned (lowered) carbonate surfaces were measured with respect to insoluble mineral grains which stand out in relief. On clear white marble the average reduction rate is 3.28 mm/100 yrs. with variations occurring with direction of exposure and height above ground surface.

W. E. DAVIES, R. L. HACKMAN, A. B. OLSON, and G. C. OHLMACHER, U. S. Geol. Survey. Safe Coal Refuse Disposal [Appalachian Plateau, Pa. to Ala.]. Project is the production of maps classifying slope stability along with an inventory of landslides. Compilation of data from aerial photographs and field investigations is on standard 7½′ quads. made available through open file. Final product will be published at 1:250,000. Present effort in Pa. covers the area south of 40° and west of 78°30′. Open file maps should be available in late 1976. Slope stability studies in the rest of western Pa. are planned to be done in 1977. ACD: 1978 for western Pa.

O. C. FARQUHAR, Univ. of Mass., and UNITED TECHNOLOGIES RESEARCH CENTER. Preliminary Evaluation of Bedrock Formations for Deep Storage of Compressed Air [SE Pa.]. ACD: 1976.

N. K. FLINT, Univ. of Pittsburgh, and W. R. ADAMS, JR., Allegheny Co. Planning and Development Dept. Causes of Landsliding in Allegheny Co.

S. R. JONES, Pa. Dept. Trans. The Yellow Breeches Thrust Near Chambers Hill, Harrisburg, Pa. Refraction seismic and electrical resistivity were used to locate the Yellow Breeches Thrust in the subject area. Information will be used in a highway design project. St. Paul Group limestone was located 70 to 100 feet below the elevations anticipated from published geological reports available for this area. Based on the Barnes Layer Resistivity values the thrust appears to be entirely within the Martinsburg shale rather than between the shale and the underlying St. Paul Group limestone. ACD: July 1976.

S. R. JONES, Pa. Dept. Trans., and R. C. OBERMAN, Pa. Dept. Environ. Resources. A Subsurface Investigation of Three Diabase Intrusives Near Bunker Hills, Lebanon Co. Proposed highway excavations will cross diabase intrusives mapped at several locations in the Bunker Hills area. Of three sites investigated, only one intrusive was confirmed in the area in which it was mapped. Refraction seismic and core borings were used in the investigation. Petrographic analyses of core boring samples were completed. ACD: Mid-1977.

ENVIRONMENTAL GEOLOGY

W. H. BOLLES, Pa. Dept. Educ., and A. R. GEYER, Pa. Geol. Survey. Catalog of Pa.'s Geologically Outstanding Areas. Geologically outstanding areas cataloged are those with values of such distinctive quality as to be of county, state or national significance and worthy of designation as a U. S. Registered Natural Landmark. ACD: Dec. 1976.

R. P. BRIGGS, U. S. Geol. Survey. Greater Pittsburgh Regional Studies. Final technical report summary and a catalog of products produced by the project. ACD: 1976.

KENT BUSHNELL, U. S. Geol. Survey/Slippery Rock State Coll. Map Showing Likelihood of Surface Subsidence Due to Underground Mining in Armstrong, Beaver, and Butler Cos. ACD: Spring 1976.

A. R. GEYER, Pa. Geol. Survey. Building Stones of Pa.'s Capitol. Booklet will describe the source, type, and appearance of stones used in numerous Capitol buildings, monuments, and other historical structures of the Harrisburg area. ACD: June 1976.

W. R. GOUGH, Moody & Assoc./The Pa. State Univ., and R. R. PARIZEK, The Pa. State Univ. The Geology and Water Resources of the Milesburg-Sayers Dam Area, Centre Co., Pa. ACD: 1976.

P. M. HUNTER and R. R. PARIZEK, The Pa. State Univ. The Environmental Geology and Hydrogeology of Portions of the Pine Grove Mills, Julian, Port Matilda, and Franklinville Quads., Pa. Project involves both basic geologic mapping and the compilation of a series of land use-related derivative maps. ACD: July 1976.

J. O. OSGOOD, Pa. Dept. Environ. Resources. Comprehensive Water Quality Management Planning Program (COWAMP). Project examines surface and subsurface waters of Pa. Includes a compilation of all existing water quality data and identifies point and nonpoint sources of pollution, critical recharge areas, soil renovation capabilities, existing and future waste disposal requirements. Also examines the physical relationships of water quality to geology, soils, mining practices, land development, competitive pressures for conflicting land uses, ability of water resources to satisfy future demands, as well as many other major factors which directly or indirectly influence water quality. Heavy emphasis is placed on public participation at all levels. Final goal is to define a general plan which integrates the type of environmental future desired by the public with the type of future that will best protect the water resources of Pennsylvania. ACD: 1978.

J. O. OSGOOD and J. A. MOSER, Pa. Dept. Environ. Resources. Hydrogeologic Element of the Comprehensive Water Quality Management Planning Program of the Pa. Area of the Erie Basin and the Erie Standard Metropolitan Statistical Area. Special emphasis is placed on the geology, structure, soils, ground-water quality and quantity, existing waste disposal practice and future requirements, polluted areas and future resource management policies of the area. ACD: July 1976.

R. R. PARIZEK, E. G. WILLIAMS, and R. J. HORNBERGER, The Pa. State Univ. Delineation of Acid Mine Drainage Potential of Coal-Bearing Strata of the Pottsville and Allegheny Groups in Western Pa. ACD: Dec. 1977.

PITTSBURGH GEOL. SOC. Home Owners Guide to Geologic Hazards — Southwestern Pa. A series of articles concerning foundation problems, floods, landslides, water supplies, septic and sewer systems and mine subsidence. ACD: 1976.

J. S. POMEROY, U. S. Geol. Survey. Southwestern Pa. Slope Stability Studies — Energy Lands [Butler, Beaver, Washington Cos.]. Intensive examination of 1975 1:24,000 photography with subsequent field checking enables investigation to formulate criteria for determining slope stability from aerial photographs and integrate it into field studies of geomorphology, geologic structures, rock lithology, soils, and slope steepness. Investigation of current coal mining activity and its relation to slope stability. ACD: 1977.

F. W. WILLIAMS and T. O. WRIGHT, Allegheny Coll. Determination of Heavy Metal Concentrations in Roadside Soils [NW Pa., along Interstate 90 in the Albion and East Springfield 7½′ quads.]. This project is to determine if and to what extent automobiles produce greater than normal heavy metal concentrations in roadside soils. The soil samples will be analyzed for acid leachable cadmium, lead, nickel, and zinc. ACD: June 1976.

J. P. WILSHUSEN, Pa. Geol. Survey, and M. E. HORNE, Consultant. Greater York Area Environmental Geology. A compilation of geologic information pertinent to the development and environmental protection of the greater York area, composed predominantly of maps with interpretive legends discussing geology, water resources, mineral resources and engineering characteristics of bedrock and soils. ACD: Sept. 1976.

GEOCHEMISTRY

C. W. POTH, U. S. Geol. Survey. Ground-Water Quality in Pa. Between 4,000 and 5,000 U. S. Geol. Survey chemical analyses of water from about 2,600 wells and springs have been computerized and will be used to give a statewide picture of ground-water chemical quality. ACD: 1976.

A. W. ROSE, M. L. KEITH, N. H. SUHR, and others, The Pa. State Univ. Geochemical Techniques for Discovery of Uranium Deposits in Northeastern Pa. Orientation studies using stream sediment, stream water and radon in water are being carried out near known occurrences near Jim Thorpe and Hughesville, Pa. Deposits are detectable using partial extractions of uranium from stream sediments. Waters show very large temporal changes. ACD: Apr. 1976.

H. A. TOURTELOT, U. S. Geol. Survey. Urban Geochemistry. To determine the effects of urbanization and industrialization on the chemical composition of soils and plants within major centers of population, and to identify urban geochemical processes and their consequences, investigations are underway involving distribution of elements around a point source, a power plant, around a diffuse source, the city of Washington, and within the heavily industrialized Allegheny and Youghiogheny River sectors of metropolitan Pittsburgh. ACD: 1978.

R. W. White, U. S. Geol. Survey. Dispersion of Elements in the Zone of Weathering. Study of the geochemistry and mineralogy of weathered profiles on 24 basaltic and 18 granitic rocks in 11 states, including a locality on diabase at the quarry 2.5 miles west of Birdsboro, Berks Co. ACD: Dec. 1976.

GEOMORPHOLOGY

R. G. CRAIG, The Pa. State Univ. Simulation of Stream Basin Organization and Development [central

Pa.]. A recursive model of the interrelationships of pertinent variables in the development of a stream basin has been derived. Approximately 8,000 measurements of lithology, elevation and slope have been obtained; further empirical data required to calibrate and test the model remain to be obtained. Interdependencies in these data are being studied by methods of Time Series Analysis and two-dimensional spatial autocorrelation functions. ACD: Sept. 1978.

W. B. WHITE, The Pa. State Univ. Caves of Pa. Work progresses to describe caves in the Valley and Ridge province of central and eastern Pa. The object is to locate, describe, and to some extent interpret every known cave in the state. ACD: Summer 1976.

W. B. WHITE and E. L. WHITE, The Pa. State Univ. Geomorphology of the Appalachian Karst [Pa. to Ala.]. To describe and interpret surface and underground landforms in selected areas of the Appalachian Highlands. An area now underway is the carbonate valleys of the folded Appalachians in Pa. New quantitative measures of karst development have been devised and are being measured from topographic maps and aerial photographs. ACD: 1984.

GEOPHYSICS

D. L. CAMPBELL, U. S. Geol. Survey. Geophysical Studies Relating to Uranium Deposits in Crystalline Terranes. Analysis and report writing from electrical resistivity data in the Gettysburg Triassic Basin will be completed. ACD: 1979.

B. F. HOWELL, JR., The Pa. State Univ. Relative Seismic Hazard in the U. S.

P. M. LAVIN and JOHN KUSIAK, The Pa. State Univ. Gravity and Magnetic Studies in Pa. Current efforts include detailed studies in the area of the Jacksonwald syncline and South Mountain anticlinorium and the correlation of lineaments with gravity and magnetic features.

K. W. VOLK, P. M. LAVIN, and A. W. ROSE, The Pa. State Univ. Rock Magnetism and Paleomagnetism of Mesozoic Intrusives in Southeastern Pa. The late-stage tectonic history of the Triassic Basin in Pa. is being studied. Secular variations have been estimated to be less than 10°. Mineralogical and petrological distinctions between types are reflected by differences in their magnetic domain structures. ACD: 1977.

R. VAN DER VOO, R. B. FRENCH, and D. WATTS, Univ. of Mich. Paleomagnetism of Paleozoic Rocks [central Appalachians]. Several formations have been sampled for paleomagnetic studies. These formations include the Rome formation, the Rose Hill formation, the Juniata sandstone, the Catskill redbeds. Completion of several paleomagnetic studies is anticipated for summer 1976. ACD: 1978.

ISIDORE ZIETZ, U. S. Geol. Survey. Regional Aeromagnetic Studies of the U. S. Hope to prepare the Pennsylvania aeromagnetic map in color this year.

GLACIAL GEOLOGY

M. F. BUCEK, H. R. B. Singer Inc., and R. B. WELLS, Pa. Geol. Survey. Surficial Deposits of Montoursville North and Huntersville Quads. [Lycoming Co.]. Mapping of the distribution of three distinct glacial till deposits, glaciofluvial sand and gravel, glaciolacustrine silt and clay, Recent alluvium and colluvium, and areas underlain by bedrock without significant unconsolidated materials. ACD: Dec. 1976.

G. H. CROWL, Ohio Wesleyan Univ., and W. D. SEVON, Pa. Geol. Survey. The Late Wisconsinan Border in Northeast Pa. Mapping of the Late Wisconsinan-Woodfordian border deposits from the Delaware River to Trout Run north of Williamsport. ACD: Aug. 1976.

G. M. FLEEGER, Bucknell Univ. Glacial and Periglacial Features in Northwestern Butler Co., Pa. Investigating possibility of extension of presently recognized glacial boundary. ACD: Jan. 1977.

F. R. NEHER and E. B. EVENSON, Lehigh Univ., and W. D. SEVON, Pa. Geol. Survey. A Quantitative Differentiation of the Glacial Drift of Northeastern Pa. Investigation of the three distinct drift sheets identified in northeastern Pa. (Illinoian, Altonian, Woodfordian). The current differentiation procedure involves the investigation of each of the three drift sheets to determine the degree of weathering as an indicator of its relative age. Parameters to be measured include: 1) depth and character of soil profile development; 2) weathering and alteration of the heavy mineral suite; 3) degree of clast weathering as measured by rind thickness; 4) depth of carbonate leaching; and 5) the clay mineral alteration sequence of each unit. ACD: Sept. 1976.

HYDROLOGY

E. S. BAIR and R. R. PARIZEK, The Pa. State Univ. Permeability Distribution in Surficial Glacial Outwash Material as Revealed by Shallow Subsurface Temperatures. During a seven month sampling period surface-water, ground-water, and soil temperatures were measured at the Edgely Well Field 12 miles north of Phila. along the floodplain of the Delaware River. Flow net analysis, water-quality data, and temperature data showed that recharge was not a result of induced infiltration from the Delaware River, two aquiferous zones are present, and a zone of increased permeability extends northwestward across the well field. ACD: Feb. 1976.

A. E. BECHER, U. S. Geol. Survey. Hydrogeology of the Great Valley in Franklin Co., Pa. Project is beginning. ACD: Jan. 1980.

A. E. BECHER, U. S. Geol. Survey. Urban and Rural Ground-Water Hydrology in the Northern Part of the Cumberland Valley. Data collection and geological mapping are complete and report is in preparation. Excellent potential exists for development of large supplies, especially from the Tomstown and Rockdale Run Formations. Water quality is good and pollution is of local origin in both rural and urban environs. ACD: June 1976.

C. E. BROWN and R. R. PARIZEK, The Pa. State Univ. Multivariate-Statistical Analysis of Chemical and Petrographic Properties Influencing Porosity and Permeability of Several Carbonate Aquifers in Central Pa. [Centre Co.]. Properties of the carbonate rocks which are most important will be used to establish a model for predicting values of porosity and permeability using a minimum amount of research on rock samples. Properties will be related to water-yielding characteristics of the various hydroformations. ACD: Nov. 1976.

L. D. CARSWELL, U. S. Geol. Survey, and T. M. BERG and W. D. SEVON, Pa. Geol. Survey. Geology and Ground-Water Resources of Pike County. Occurrence, availability, movement, and chemical quality of ground water in the unconsolidated Pleistocene deposits and in the bedrock will be investigated throughout the county. Of particular interest are the Pleistocene deposits in the valley of the Delaware River, which form a reservoir of ground water up to several hundred feet thick. ACD: July 1979.

R. M. FOOSE, Amherst Coll. Ground Water Storage and Movement in the Carbonate Rocks of the Hershey Valley. Research continues by extensive monitoring of the total behavior of ground water in the carbonate rocks of the Hershey Valley. This involves the collection of data dealing with precipitation, influent seepage, ground water levels, porosity and permeability with respect to structural controls and depth, rates of movement, and discharge as springs and base flow in the Hershey Valley. ACD: 1980.

W. R. FRANTZ, Bloomsburg State Coll. Selected Hydrologic Characteristics of Green Creek, Columbia Co., Pa. Project includes such hydrological parameters of Green Creek and its tributaries as stream hydrograph, sediment load, chemical analysis, plus measurable changes in channel configuration. ACD: Jan. 1977.

J. T. GALLAHER, HARRY KOESTER, and T. F. BUCKWALTER, U. S. Geol. Survey. Hydrology and Geology of Erie County, Pa. ACD: Dec. 1978.

J. M. GERHART and R. R. PARIZEK, The Pa. State Univ. A study of the quantity and quality of the ground water in the Pocono sandstone of Clearfield Co. using digital modelling techniques. ACD: Summer 1976.

D. J. GROWITZ and M. M. BEARD, U. S. Geol. Survey. Coal-Mine Discharges in the Anthracite Fields of Pa. An overview of the hydrology of the anthracite region. Compilation of data from a recent mass-sampling program in the four anthracite fields indicates the average daily flow of mine drainage amounts to about 900 cubic feet per second, the average acid load (to pH 7 as H_2SO_4) is approximately 300 tons per day, and the average total dissolved iron load is about 75 tons per day. In excess of 80% of the total mine drainage and acid load is discharged to the Susquehanna River basin; the remaining flow enters the Delaware River basin. ACD: July 1976.

E. D. HESS, Pa. Geol. Survey. Pa. Water Well Inventory. Identification of lithologic units, positioning of wells by coordinates, and analysis of rock units as potential aquifers.

W. A. HOBBA, JR., and J. C. CHEMERYS, U. S. Geol. Survey. Reconnaissance Appraisal of the Thermal Springs of the Appalachian Mountains [Ga. to N.Y.]. The principal objective is to describe the physical and chemical character of the thermal springs based on modern investigative techniques. Emphasis is being placed on the collection of hydro-geochemical data from which residence times and maximum temperatures at depth can be inferred. Data have been collected on numerous wells, cold springs and warm springs. Samples have been collected from 36 selected wells and springs and are being analyzed for gases, trace metals, several isotopes, and other common dissolved constituents. ACD: Sept. 1976.

L. J. McGREEVY and R. A. SLOTO, U. S. Geol. Survey. Ground-Water Resources of Chester Co., Pa. ACD: July 1976.

H. W. RAUCH and M. P. LaRICCIA, W. Va. Univ. A Study of Structural Geologic Variables Related to Water Well Productivity in Pa. [Lebanon Valley, Lancaster Co., and central Chester Co.]. We are investigating the effects of mapped photo-lineaments (from both large- and small-scale photography), structural fold axes, and faults on water well productivity. ACD: Aug. 1976.

G. R. SCHINER, HARRY KOESTER, T. F. BUCKWALTER, and CLIFFORD DODGE, U. S. Geol. Survey. Water Resources of the Clarion River and Redbank Creek Basins in Western Pa. ACD: Oct. 1978.

E. T. SHUSTER, Pa. Geol. Survey. Hydrogeology of the DuBois Area, Jefferson and Clearfield Cos. ACD: 1976.

E. L. WHITE, The Pa. State Univ. Role of Carbonate Rocks in Modifying Extreme Flow Behavior [Appalachian Highlands]. Flood and sustained flow measures for 62 carbonate basins located in the Appalachian Highlands were analyzed with respect to their basin and karst measures. ACD: Completed.

W. B. WHITE and E. L. WHITE, The Pa. State Univ. Characterization of Carbonate Aquifers by Spring Discharge Hydrographs [eastern U. S.]. Specific storm event hydrographs are compiled for gaged limestone springs and values for response time, storage coefficient, and peak/base flow discharge calculated. These are then correlated over period of record and over storms of differing intensity. ACD: 1976.

C. R. WOOD, U. S. Geol. Survey. Ground-Water Resources of the Gettysburg Formation. ACD: June 1979.

IGNEOUS AND METAMORPHIC PETROLOGY

M. L. CRAWFORD, Bryn Mawr Coll. Study of Mineral Compositions in the Wissahickon Schist. Composition and zoning pattern in garnet, plagioclase and epidote from selected samples of schist are being determined to identify the reactions between calcium-bearing minerals in pelitic schists. ACD: 1977.

A. A. DRAKE, JR., and R. I. TILLING, U. S. Geol. Survey. Petrochemistry of the Precambrian Rocks of the Reading Prong [eastern Pa., northern N. J., SE N. Y.]. Project temporarily recessed.

W. F. THOMANN and W. A. CRAWFORD, Bryn Mawr Coll. Igneous and Metamorphic Petrology of the Honey Brook Uplands [Honey Brook, Wagontown 7½′ quads. and major portions of the Elverson and Pottstown 7½′ quads.]. Crystalline rocks west, north and northeast of the Honey Brook anorthosite will be remapped within the Honey Brook uplands. Data collected will be used to apply appropriate modern terminology to the rock units, to determine the premetamorphic origin of the rocks, and to ascertain the grade and number of metamorphic events. ACD: Apr. 1977.

CYNTHIA WOOD and M. L. CRAWFORD, Bryn Mawr Coll. Fluid Inclusion Studies of Quartz Vein Assemblages in the Octorara Phyllite [Coatesville 15′ quad.]. ACD: 1976.

MINERALOGY

J. H. BARNES, Pa. Geol. Survey, and W. F. DOWNEY, JR., Juniata Coll. Mineralogy Associated with

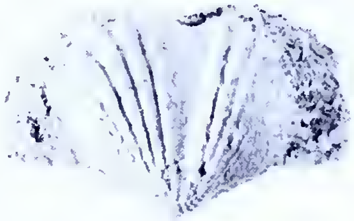
Burning Anthracite Deposits [Luzerne, Schuylkill, N. Dauphin Cos.]. Study of minerals forming from sublimation of gases produced by subsurface fires in anthracite mines and culm banks. ACD: 1976.

G. W. BRINDLEY and D. L. BISH, The Pa. State Univ. Currently studying the hydrous nickel-containing layer silicates (garnierites), and related minerals, including kerolite, deweylite, pimelite, etc. Our objective is a study of the crystal chemistry of these minerals and a clarification of the nomenclature.

D. K. SMITH and ADEL DABBOUS, The Pa. State Univ. Characterization of Uranium Minerals from the Williams Quarry. Three secondary uranium minerals from the C. K. Williams Quarry, Easton, Pa., are being characterized by microprobe and scanning microscopic studies. The species may be new minerals, or at least new to Pa. ACD: Fall 1976.

R. C. SMITH, II, Pa. Geol. Survey, M. L. ANNE and others, and Friends of Mineralogy, Pa. Mineralogy of Pennsylvania, 1965-1975. Sixty species new to the state are described in detail with physical properties, chemistry, and precise location supplemented by crystal drawings, reproductions of old mine maps, geologic cross sections, and photographs. ACD: Dec. 1976.

PALEONTOLOGY



BRUCE CORNET and ALFRED TRAVERSE, The Pa. State Univ. Palynology, Chronology, and Paleoecology of the Newark Group Basins in the Eastern U. S. A palynoflorule from the lowest New Oxford Formation of the Gettysburg Basin, Pa., indicates a middle Carnian age, while a palynoflorule from the Heidlersburg Member of the Gettysburg Shale indicates a Norian age. A palynofloral succession just below the Jacksonwald basalt of the Newark Basin in Pa. has restricted the Triassic/Jurassic boundary to 60 stratigraphic feet of outcrop. A major floral change occurs at the boundary, accompanied by a change from shale to mudstone. ACD: Aug. 1976.

JACK DONAHUE, H. B. ROLLINS, PETER DICKSON, STEVE DODIN, JOHN HARPER, MARSHALL CAROTHER, and JOHN FIERSTEIN, Univ. of Pitt. Paleoecology of Conemaugh Marine Events [SW Pa.]. Reconstruction of Conemaugh marine benthic communities.

A. G. EPSTEIN, U. S. Geol. Survey. Paleozoic Stratigraphy, Appalachian Region—Appalachian Basin Conodont Studies. Analyses of conodont faunas in Ordovician through Pennsylvanian age rocks to determine distribution in time and space, and conodont-color alteration to produce detailed maps of areas for oil and gas potential in the Appalachian Basin.

E. B. GIFFIN, William Penn Mem. Mus. Thelodont Denticles from the Bloomsburg Formation of Central Pa. ACD: 1976.

P. W. GOODWIN, E. J. ANDERSON, and JOHN WAGNER, Temple Univ. Trace Fossils in Paleozoic Tidal Quartzites [SE and central Pa.]. ACD: Spring 1977.

W. F. KLOSE II, Paleontological Research Inst. Cones and Metaspores of *Lepidocarpon* from Pennsylvania [NE Pa.]. Materials for the study collected and curated. Review of specimens (types) at the USNM completed. ACD: 1977.

W. F. KLOSE II and DONALD BADMAN, Paleontological Research Inst.
1. Additions to the Coal Fauna (Allegheny) of Pennsylvania [NE Pa.]. Specimens of crustaceans, insects and medusa found in the past few years will be treated. ACD: 1978.
2. The Flora of the Baltimore Coal (Allegheny) [Wilkes-Barre]. ACD: 1979.
3. The Flora of the Clark Coal, Carbondale, Pa. ACD: 1977.
4. The Flora of the Sugarnotch 2 Vein. ACD: 1978.
5. The Flora and Fauna of the Buck Mountain 5 Coal [Southern Anthracite Basin]. A study of fossil plants, insects and crustacea from the Buck Mt. 5 coal (Basal Allegheny Series) in the Southern Anthracite Basin in the Klose, Badman, William Penn Memorial Museum, USNM, and Reading Public Museum (Unger Collection) collections. ACD: 1980.

W. F. KLOSE II and CHARLES KLINE, Mineralogical Society of NE Pa. Curation of The Edward S. Jones Collection [Lackawanna Historical Society]. Curation and cataloging of 140 exceptional fossil plants. Complete. Curation of the mineralogical collections 50% complete. ACD: 1977.

A. J. MIKLAUSEN, Shippensburg State Coll. Contributions to the Fossil Flora of the Mississippian. ACD: Dec. 1977.

W. A. OLIVER, JR., U. S. Geol. Survey. Biostratigraphy and Systematic Paleontology of Rugose Corals in the Keyser Limestone. ACD: 1978.

BARRY PERLMUTTER, Jersey City State Coll. Conodonts from the Keyser Limestone (Silurian-Devonian) and the Helderberg Group (Devonian) in Pa. and W. Va. The conodonts will be described and illustrated. The individual conodont elements will be grouped to form the whole organism empirically based on models previously developed. An attempt will be made to relate these conodont apparatuses to the environments represented. ACD: Feb. 1977.

JEROME RACKOFF, Bucknell Univ. On the Origin of the Tetrapod Limb. *Sterropterygion* (U. Dev., Lycoming Co.) is more tetrapod-like than any other known rhipidistian fish in the morphology of the paired fin skeletons, the pattern of mobility of the fin joints, and the presence of the first pre-tetrapod ankle joint. New information on fin orientation suggests the manner in which the difference between the fore and hind limbs of tetrapods arose. ACD: 1976.

JOHN STOLAR and ALFRED TRAVERSE, The Pa. State Univ. Megaspores from Some Upper Devonian and Lower Mississippian Deltaic Sediments of Central Pa. The uppermost Chemung, the Catskill, and the lowermost Pocono Formations have been extensively sampled for megaspores. The object of the study is to locate the local Devonian-Mississippian stratigraphic boundary based on the megaspore genera that are present. Preliminary findings show that megaspores are abundant in the siltstones and coaly shales of the Chemung and Pocono Formations. ACD: Aug. 1976.

R. E. THOMS, Portland State Univ., and T. M. BERG, Pa. Geol. Survey. Studies on Vectoral Analysis of *Pelecypodichnus*. Studies on the form and function of the Recent freshwater mussel, *Margaritifera margaritifera* are being made in order to establish a valid means of interpreting *Pelecypodichnus* structures in the basal Catskill. If validly interpreted, these primary biogenic structures will aid in reconstruction of the ancient sedimentary environment.

SEDIMENTOLOGY

J. R. BEERBOWER, KATHY GERETY and MIKE KROLL, SUNY at Binghamton. Biogenic and Pedogenic Features in Catskill Formation (Devonian).ACD: June 1977.

J. R. BEERBOWER and STEVEN STANCEL, SUNY at Binghamton. Stratigraphy and Sedimentology of Mauch Chunk Formation (Mississippian). ACD: June 1977.

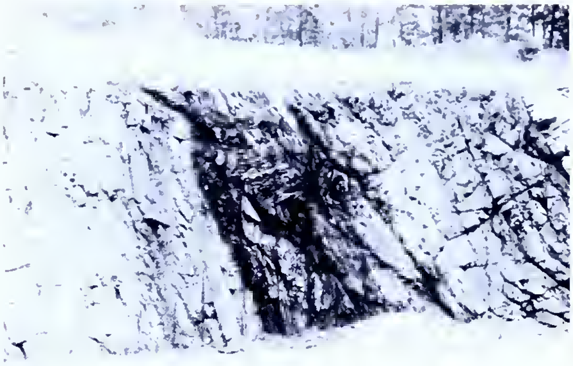
JACK DONAHUE, JAMES ADORASIO and JOEL GUNN, Univ. of Pitt., and ROBERT STUCKENRATH, Smithsonian Institution. Meadowcroft Rock Shelter [Avella, Washington Co.]. Sedimentology of the Meadowcroft paleo-Indian rock shelter. The site is a colluvial fill of sediments located on the north side of Cross Creek. Sedimentation has occurred during at least the past 16,000 years. Precise rates for colluvial sedimentation and rock face migration are being established. ACD: 1978.

ALAN DONALDSON, W. Va. Univ. Petrology of Lower Kittanning Coal.

M. E. KAUFFMAN, Franklin and Marshall Coll. Barrier Islands, a New Interpretation of Antietam Formation. The outcrop pattern of the Antietam Formation can best be interpreted as a series of barrier islands in front of the linear clastic shoreline of Early Cambrian seas. The long discontinuous Antietam ridges have heretofore been variously interpreted as fault-bounded blocks or slices associated with imagined thrust and/or normal faults. Mapping over a period of years in the Lancaster-Morgantown area has suggested a sedimentary explanation for these Antietam sandstone bodies. ACD: Fall 1977.

M. E. KAUFFMAN and R. D. K. THOMAS, Franklin and Marshall Coll. Paleoenvironmental Significance of Cambrian Carbonates near Morgantown, Pa.

STRATIGRAPHY



PING-FAN CHEN, W. Va. Geol. Survey. Stratigraphy and Tectonics of Lower Paleozoic Rocks in Central Appalachians. Detailed discussion for each formation on name, distribution, description, thickness, lithofacies, stratigraphic relationships, environments, and sources with measured sections appended. Detailed discussion on the tectonics from the Blue Ridge to the Appalachian Plateau provinces in central Appalachians. ACD: Spring 1976.

J. M. DENNISON, Univ. of N. C. Hamilton Group Stratigraphy of Devonian Fulton Lobe [Va., W. Va., Md., and Pa.] . ACD: 1979.

J. M. DENNISON, Univ. of N. C. Paleozoic Eustatic Sea-Level Changes in Appalachian Basin. ACD: 1977.

J. M. DENNISON and D. A. TEXTORIS, Univ. of N. C. Stratigraphy and Petrology of Tioga Bentonite (Devonian) [Appalachian Basin] . ACD: 1977.

W. E. EDMUNDS, A. D. GLOVER, M. A. SHOLES, and V. W. SKEMA, Pa. Geol. Survey. TASIC (Temporarily Available Stratigraphic Information Collection). This project is a continuing program involved with the recovery of stratigraphic data from active coal and clay strip mines and construction sites while exposures are available. The long-term project is designed to provide data for future mapping and regional mineral resource evaluation.

P. W. GOODWIN, PETER FRISCHMANN and WILLIAM WADE, Temple Univ. Middle Ordovician Carbonate Paleoenvironments and Stratigraphy [central Pa.] . ACD: Spring 1977.

LOUIS HEYMAN, Pa. Geol. Survey. Oriskany (Lower Devonian) and Related Sandstones in the Subsurface of Western Pa. Rocks previously mapped as "Oriskany" in the subsurface of Pa. comprise all of the following: a sandy carbonate to sandstone zone in the upper Helderberg Group, the Ridgeley Sandstone (Oriskany Sandstone proper), and sandstone lenses in the basal portion of the Bois Blanc

(Lower Devonian) Formation and locally perhaps in the basal portion of the Onondaga Group. Data are at present being compiled for map(s) at 1:250,000 which will show the distribution of these units and their thickness. ACD: 1977.

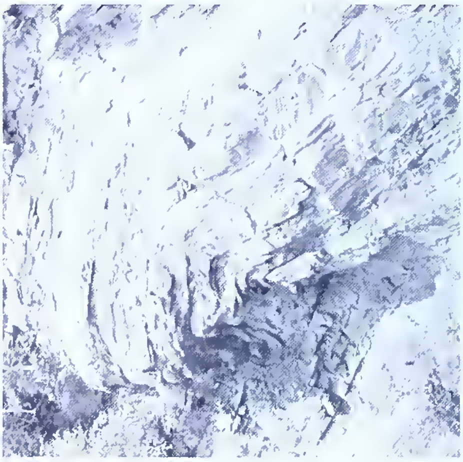
LOUIS HEYMAN, Pa. Geol. Survey. Subcrop Map of the Rocks Beneath Onesquethaw Stage Rocks in the Subsurface of Western Pa. In a large area of western Pa., the Onondaga Group, Huntersville Chert, Needmore Shale and Bois Blanc Formation overlie rocks ranging from the Ridgeley (Lower Devonian) Sandstone to Bertie-Bass Islands (Upper Silurian). Map will be at scale 1:250,000.

R. G. PIOTROWSKI, Pa. Geol. Survey. Upper Devonian Subsurface Framework Stratigraphy of Western Pa. This framework will consist of a series of gamma ray logs showing regional correlations, hydrocarbon-bearing zones, and facies relations for the Upper Devonian in western Pa. ACD: 1976.

B. F. ROWELL and field geology class students, Kutztown State Coll. Stratigraphy of the Kutztown Quad. ACD: May 1976.

T. O. WRIGHT, Allegheny Coll., and G. C. STEPHENS, Bryn Mawr Coll. Martinsburg of Eastern Pa. Investigation of the stratigraphic relationships between the various Middle and Upper Ordovician clastic rocks of eastern Pa. ACD: 1977.

STRUCTURAL GEOLOGY



R. T. FAILL, Pa. Geol. Survey. Fossil Deformation in the Valley and Ridge Province, Central Pa. Fossils throughout the province exhibit angular and shape distortions caused by a penetrative deformation. Crinoid columns have been collected and are being measured to evaluate the magnitude, orientation, and dynamics of the deformation. ACD: 1977.

PETER GEISER, Univ. of Conn. An Investigation of Regional Prefolding Cleavage in the Valley and Ridge Province of the Central Appalachians. ACD: 1979.

LOUIS HEYMAN, Pa. Geol. Survey. Map of Subsurface Structure of Western Pa. In many areas, the Ridgeley (Oriskany) Sandstone is unconformable on subjacent rocks or is absent, so that at least two pre-Oriskany horizons will be used in different areas as structural datum planes. Where the Ridgeley is conformable, the top of the Ridgeley will be used as a structural datum. Map will be at scale 1:250,000. ACD: 1977.

W. S. KOWALIK, U. S. Geol. Survey. Lake Wallenpaupack Circular Feature. A well-expressed circular drainage pattern of unknown origin was detected on Landsat imagery of the Pocono Plateau east of Scranton. Field reconnaissance of the feature indicated no obvious consistent structure throughout the 25-km-diameter feature. An aeromagnetic anomaly is present over the feature. Structural mapping and a gravity survey in the area are planned. ACD: Fall 1976.

W. S. KOWALIK, D. P. GOLD, S. S. ALEXANDER, U. S. Geol. Survey, and various graduate students. Everett Lineament [between Everett and Breezewood]. Geologic mapping is being conducted in conjunction with geophysical work to accurately determine the nature and location of a major cross strike discontinuity which appears to extend from South Mountain to the Allegheny Front. The lineament/discontinuity is expressed by enechelon faulting just west of Everett and is characterized generally as a zone along which many major folds plunge. ACD: Summer 1976.

S. I. ROOT and D. B. MacLACHLAN, Pa. Geol. Survey. Southern Limit of Taconic Allochthons in Pa.

S. I. ROOT and D. B. MacLACHLAN, Pa. Geol. Survey. Structural Geology of the Gettysburg Basin.

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BRIGGS, R. P., and KOHL, W. R., 1975, Map of zones where land use can be affected by landsliding, flooding, and undermining, Allegheny County, Pennsylvania. U. S. Geol. Survey Misc. Field Studies Map MF-685-D.

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BUCEK, M. F., 1975, Pleistocene geology and history of the West Branch of the Susquehanna River valley near Williamsport, Pennsylvania. The Pa. State Univ., Dept. of Geosciences, unpub. Ph.D. dissertation.

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BUSHNELL, KENT, 1975, Map showing depths to the Pittsburgh coal bed, mining activity, and related surface subsidence, Allegheny, Washington, and Westmoreland Counties, Pennsylvania. U. S. Geol. Survey Misc. Field Studies Map MF-693-A.

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ANNOUNCEMENTS

GEM & MINERAL SHOW

The East Hempfield Lions Club is sponsoring its Second Annual Gem & Mineral Show on October 16 and 17 at the Lancaster County Farm and Home Center, 1383 Arcadia Road (off Pa. Rt. 72 at U.S. 30). Hours are 10 a.m.-9 p.m. on the 16th; 10 a.m.-6 p.m. on the 17th.

GEM AND MINERAL SHOW AT HERSHEY

The Central Pennsylvania Rock and Mineral Club will hold its 11th Annual Gem and Mineral Show in the Blue Room of the Hershey Community Building. October 9th from 10 a.m. to 9 p.m. and October 10th from 10 a.m. to 6 p.m. There will be demonstrations in stone cutting and polishing and silversmithing. Admission will be charged. Adults $1.00 Students $.50.

GEMERAMA

The Tuscarora Lapidary Society, "Gemerama '76" will be held on September 11 and 12, 1976, at the Holiday Inn in Lima, Del. Co., Penna., Rt. U.S. #1, opposite Granite Run Mall. Hours will be from 10:00 a.m. to 10:00 p.m. on Saturday and 10:00 a.m. to 6:00 p.m. on Sunday.

"LITHIUM—NATURE'S LIGHTEST METAL", 15 pages

Lithium is the lightest of all metals, and has the highest electrical potential when used in batteries. Furthermore, it can be split to form tritium, an essential fuel element in the generation of power by fusion reaction. Because these new uses may play a major role in solving our energy problems, the U.S. Geological Survey has begun to search for sources of lithium.

This pamphlet is available free of charge from the U.S. Geological Survey, Distribution Section, 1200 South Eads Street, Arlington, Virginia 22202.

FROM THE DESK OF THE STATE GEOLOGIST (Continued from page 1)

The historical progression down to one remaining zinc mine does not necessarily point to early extinction of Pennsylvania's zinc-lead mining. New and sophisticated exploration techniques, improved and efficient milling methods, and increased demand and prices for lead and zinc all point to the need for reexamining and reassessing Pennsylvania's widespread occurrences. Just such a project is being completed by Dr. Robert Smith of the Pennsylvania Geological Survey. As soon as completed the results will be made available to all. We feel very confident that the information will enable Pennsylvania to witness the development of new production of lead and zinc, so vital to the nation's economy and security.

Arthur A. Socolow

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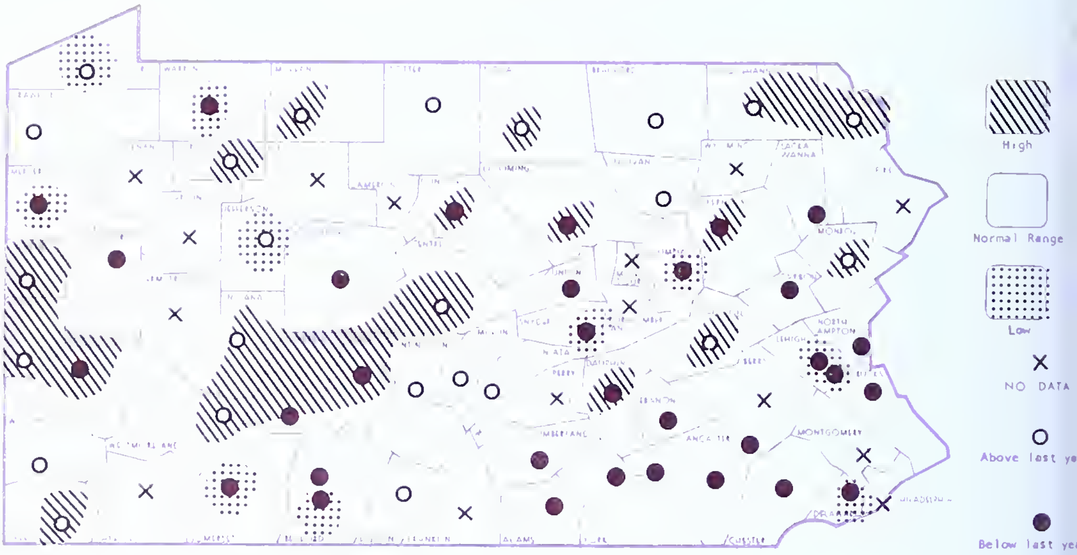

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COMMONWEALTH OF PENNSYLVANIA
Milton J. Shapp, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES
Maurice K. Goddard, Secretary

TOPOGRAPHIC AND GEOLOGICAL SURVEY
Arthur A. Socolow, State Geologist

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ON THE COVER: Bicentennial gift to Queen Elizabeth, presented in Philadelphia by Governor Shapp on behalf of the Commonwealth. Photo courtesy of F. J. Cooper Inc. of Philadelphia. See story, page 2.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

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OCTOBER 1976

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FROM THE DESK
OF THE
STATE GEOLOGIST . . .

WHAT IF

Our vehement reaction to the Arab oil embargo of 1972 was not simply out of concern for our comforts and economic well-being, but it was also an expression of rage over the insult to the freedom of mankind's right to utilize a natural resource with which our Earth has been endowed. Ironically, one does not need to look back upon that Middle East event for an example of such restriction to man's right of access - it is happening right here, all around us.

In several of our western states as much as 73% of the state's land area has been placed off limits for mineral exploration, much of that area with potentialities for energy resources and other vital minerals for which we are now dependent upon foreign sources.

That same syndrome has spread to eastern United States. One state after another, faced with varied sources of opposition, is taking the easy way out by saying "No, don't look in our area - even if we have it we don't want anyone digging for it." And it goes even beyond our shores, as many of the Atlantic coastal states are objecting to exploration for oil and gas on the continental shelf even while they are short of these commodities.

Even in Pennsylvania we find that many sectors of the mineral industry, attracted by new evidence of mineral occurrences long overlooked, are finding that access to both private and state lands has become extremely difficult - and in many cases totally impossible.

True, this restricted access often has merit. There are environmental treasures to be protected and there is a record of many horrendous past misdeeds. But while we must establish rules and guidelines to protect our heritage, we must not simply close the door upon our natural resource endowments.

What if Texas, Oklahoma, Louisiana, and California had said "You can't drill for oil here." What if Minnesota and Michigan had said "Don't dig for iron here." What if Pennsylvania, Kentucky, and West Virginia said "Don't dig our coal", and Florida said "Don't dig our phosphates", and Colorado said "Don't dig our molybdenum" and California said "Don't dig our gold", and Arizona said "Don't dig our copper!" And then what if the rest of the world said "Don't dig here!"

Yes, we'd have a clean and tidy landscape - but very little else!

But what if we set some meaningful rules and guidelines and see to it that they are enforced? And what if we recognize that the Earth is unevenly endowed with wonderful and precious resources and we recognize that we can't go on saying "Dig elsewhere, not here." What if?

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From Our Mineral Collection

TO THE QUEEN

The Pennsylvania Geological Survey is most pleased to have played a small part in honoring Queen Elizabeth of Britain during her Bicentennial visit to Philadelphia in July.

Several months ago we were approached by a representative of the Governor's Office to see if we could provide a mineral specimen that would be native to Pennsylvania, as well as esthetically outstanding. We reviewed our mineral collection and selected a brilliant cluster of quartz crystals which had just recently been collected from the Lehigh River Gap, near White Haven, by Alan Geyer, Chief of our Environmental Geology Division.

The Governor's Office accepted our specimen with enthusiasm and subsequently arranged for a handcrafted vermeil bush of mountain laurel, the Pennsylvania State flower, to be joined with the quartz crystal cluster to form the outstanding creation which is pictured on the cover of this issue. The gift to Queen Elizabeth was presented by Governor Milton Shapp on behalf of the Commonwealth on July 6, 1976, at Philadelphia.

We appreciate the cooperation of F. J. Cooper, Inc., of Philadelphia, which handcrafted the gift, in making the photograph available to us for publication. It has previously appeared in the New Yorker Magazine and in Gourmet Magazine.

surplus topographic maps

As a result of the ongoing program of revising and updating Pennsylvania's topographic maps, we now have a number of quadrangle maps which are out of date and are, therefore, surplus. These are still excellent for group or classroom instruction in map reading and profile exercises. These surplus maps will be provided at no charge as long as they last. Please advise how many different quadrangles are desired and how many copies of each quadrangle. Address requests to: Pennsylvania Geological Survey, 914 Executive House, Harrisburg, PA 17120.

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SURVEY ANNOUNCEMENTS

MINERAL COLLECTING IN PENNSYLVANIA NOW REVISED

Mineral Collecting in Pennsylvania, the most popular and best-selling publication ever issued by the Pennsylvania Geological Survey, has been completely revised and reissued. Authored by Messrs. Alan R. Geyer, Robert C. Smith II, and John H. Barnes, the 260-page report details the specific locations and available minerals at 63 localities in 31 counties across Pennsylvania. Included in the report are guidelines to mineral identification, collecting procedures, and lists of museums and mineral clubs in Pennsylvania. Special note has been made of the need for safety and for respect of private properties.

The new, fourth edition of **Mineral Collecting in Pennsylvania** is dedicated to Dr. Davis Lapham, who co-authored the first three editions of this publication. An avid collector himself, and a dedicated friend to all collectors, Dr. Lapham served as Chief Mineralogist of the Pennsylvania Geologic Survey until his death in December, 1974.

The newly revised Bulletin G 33 will be of widespread interest to the thousands of Pennsylvanians who singly, in family outings, and with clubs and groups engage in one of the most satisfying recreational experiences, mineral collecting.

Bulletin G 33, **Mineral Collecting in Pennsylvania**, is available for $1.60 (plus $0.10 tax for Pennsylvania residents) from the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, PA 17125.

SABULA-PENFIELD QUADRANGLES, CLEARFIELD COUNTY

An area with major coal and gas resources is described in a new, comprehensive report by Messrs. Thomas M. Berg and Albert D. Glover of the Pennsylvania Geological Survey. "Geology and Mineral Resources of the Sabula-Penfield Quadrangles" deals with a 112 square mile area of northwestern Clearfield County, with small portions of Elk and Jefferson Counties included. The report, with geologic maps, sections, and tables, details the distribution and reserves of the coal deposits and the locations of existing gas-producing wells. These data along with the structural and stratigraphic descriptions of the area will be important in the exploration and potential development of new resources. Measurements indicate remaining re-

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serves of over 150 million tons of Lower Kittanning coal over 28 inches thick in the mapped area; in addition, there may be undiscovered gas pools at greater depths.

This report should be useful to the mineral industries, as well as to planners, professional geologists, engineers, and conservationists. Industries that have a need for a particular nonmetallic mineral or rock type may be able to locate potential economic deposits in the area. Professional geologists will be able to use the basic stratigraphic and structural data in this report for regional and topical interpretations. Highway and construction engineers should find the report helpful in evaluating future construction sites. The report will provide a basic geologic framework for conservationists and planners in the prevention of water pollution, in the intelligent and responsible application of land planning, and in the more efficient development of mineral resources in the future.

Atlas 74ab, "Geology and Mineral Resources of the Sabula – Penfield Quadrangles" is available for $18.80 (plus $1.13 tax for Pa. residents) from the Pa. Bureau of Publications, P. O. Box 1365, Harrisburg, PA 17125.

REPORT ON BRODHEADSVILLE AREA, MONROE COUNTY

The bedrock and surficial geological environment of a rapidly developing region in the Pocono Mountain Area have been mapped and described in the new geologic Atlas 205a, "Geology and Mineral Resources of the Brodheadsville Quadrangle", by Thomas M. Berg of the Pennsylvania Geological Survey. Particular attention is paid in this report to the mineral resources which have economic potential, and to the environmental characteristics, including engineering rock properties and water resources, which are critical to wise land use planning. The full-color, bedrock geologic map of this 56 square mile area of southwestern Monroe County is accompanied by a separate map of unconsolidated surficial materials, particularly important in this region of glacial deposits.

The wide range of environmental information included in the text and maps of this geologic atlas will be of aid to planners, transportation and recreation officials, engineers, and all who are concerned with the proper relationship of man to his physical environment.

Atlas A 205a, "Geologic and Mineral Resources of the Brodheadsville Quadrangle" is available from the Pa. Bureau of Publications, P. O. Box 1365, Harrisburg, PA 17125 for $9.50 (plus $0.57 tax for Pennsylvania residents).

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OIL CITY QUADRANGLE REPORTS NOW ON OPEN FILE

Reports and maps prepared by the Pennsylvania Geological Survey for study of the bedrock and general geology, mineral resources and engineering characteristics of the Oil City Quadrangle, Venango County, Pennsylvania, are now on open file for inspection at the Survey offices in Harrisburg and Pittsburgh. These reports and maps were prepared under a grant from the National Science Foundation to the Pennsylvania Geological Survey. Work was accomplished by geologists from Slippery Rock and Edinboro State Colleges and the Pennsylvania Geological Survey.

Five reports with accompanying plates were prepared:

1. A user's guide to the geologic map of the Oil City 7½-minute quadrangle, Venango County, Pennsylvania.
2. A user's guide to the potential mineral resources of the Oil City 7½-minute quadrangle, Venango County, Pennsylvania.
3. A user's guide to the glacial map of the Oil City 7½-minute quadrangle, Venango County, Pennsylvania.
4. A user's guide to the engineering characteristics of bedrock of the Oil City 7½-minute quadrangle, Venango County, Pennsylvania.
5. A user's guide to the oil and gas well distribution of the Oil City 7½-minute quadrangle, Venango County, Pennsylvania.

Each report is intended to describe to a non-technically trained reader how to use the respective subject maps.

Each report and map is also available free of charge on a microfiche (text) and microcard (map). To obtain these write to the Pennsylvania Geological Survey, Department of Environmental Resources, P. O. 2357, Harrisburg, Pennsylvania, 17120.

GEOLOGY OF THE SINKING SPRING QUADRANGLE

A detailed geologic map and report on an area of approximately 60 square miles just west of the City of Reading has been published by the Pennsylvania Geological Survey as Geologic Atlas 177d, "Geology and Mineral Resources of the Sinking Spring Quadrangle, Berks and Lancaster Counties." Authored by David B. MacLachlan, Tracy V. Buckwalter, and Dean B. McLaughlin, the 228-page report, with full-color geologic maps, deals with the distribution, composition, geologic history, and economic potential of the bedrock units and unconsolidated sediments of the area.

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This rapidly developing area includes four geologically and topographically distinct terrains involving some of the most complex geologic structures of the eastern United States. As the land and its resources are increasingly being used, the information in this report is an important contribution towards proper planning and land use management. The rock characteristics, water and mineral potential, and engineering conditions in the area will be of particular interest to planners, industry, engineers, and the public.

Atlas A 177d is available for $17.50 (plus tax for Pennsylvania residents) from the Pa. Bureau of Publications, P. O. Box 1365, Harrisburg, PA 17125.

OIL FIELDS OF THE GREATER PITTSBURGH REGION

The Greater Pittsburgh region, consisting of Allegheny, Armstrong, Beaver, Butler, and Westmoreland Counties, is underlain by 92 known oil fields. The largest well in the area has produced over one million barrels of crude oil and is still producing. Allegheny County alone has produced over 79 million barrels by January of 1976, while Washington County has produced over 71 million barrels.

This significant data is included in a wealth of information provided in the newly released report on "Oil Fields of the Greater Pittsburgh Region" by William S. Lytle of the Pennsylvania Geological Survey. Sponsored in part by the U. S. Geological Survey, the report not only provides the production history of each county for each year, but also gives the geological and historical record of each of the oil fields of the area.

Most important, this is not simply a report of the past, but an analytical projection of the future. On the basis of the best available present data and reserve calculations, it is projected that the six county areas will produce between now and the year 2000 an additional 3,680,670 barrels of crude oil.

This report will be of interest to planners in the area, petroleum geologists, and producers, and all who are concerned with oil history past and energy resources for the future. This new 119-page report, is a logical companion-piece to the recently published Map #44, "Greater Pittsburgh Region Oil and Gas Fields Map" (price $3.70 plus tax).

Mineral Resource Report 70, "Oil and Gas Fields of the Greater Pittsburgh Region" is available from the Pa. Bureau of Publications, P. O. Box 1365, Harrisburg, Pennsylvania, 17125, for $1.65 (plus $0.10 tax for Pennsylvania residents).

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REPORT ON THE MILLERSBURG QUADRANGLE OF CENTRAL PENNSYLVANIA

A complete and detailed description of the geologic environment of the Millersburg region in central Pennsylvania is presented in the Pennsylvania Geologic Survey's new publication, Atlas A 146, Geology **and Mineral Resources of the Millersburg Quadrangle.** This actively developing area lies astride the Susquehanna River and includes portions of Dauphin, Juniata, Northumberland, Perry, and Snyder Counties.

Authored by Dr. Donald M. Hoskins, the new report, complete with full-colored geologic maps and cross sections, provides detailed information on the nature and distribution of the rock units, the local mineral resources, and the available groundwater resources. The new report should be of benefit to the numerous growing communities in the area as they address themselves to problems of land use planning, engineering and transportation design, water supplies, and domestic and industrial construction projects.

The summary statements on the map legend, including economic resources, water resources, engineering geology, and environmental characteristics, are designed to make the information readily understandable to all prospective users. Atlas 146, Geology and Mineral **Resources of the Millersburg Quadrangle** is available for $12.80 (plus $0.77 tax for Pa. residents) from the Pa. Bureau of Publications, P. O. Box 1365, Harrisburg, PA 17125.

Stalking the Trilobite on Sherman Ridge

by Barbara Conrad

This article is meant to assist people who have been searching for trilobites for years, and have come to the conclusion that they exist only in books. A good place to look for these fossils is in the upper shale and siltstone units of the Sherman Ridge Formation in Perry County, south of Ickesburg. During the Middle Devonian Era, this shale was silt and sand that was being deposited in a shallow offshore marine environment.

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Trilobites are fossil, aquatic arthropods. They are unusual because they are the remains of some of the earliest creatures on earth to evolve a chitonous, segmented exoskeleton, a pair of jointed appendages for each segment, a well developed brain, and compound eyes.

One of the reasons for the uncommon occurrence of complete trilobite fossils is the fact that they were very vulnerable to their environment during several stages in their life cycles, particularly during molting. In the formation mentioned above, three types of trilobites can be found: Genus—Trimerus, Subgenus—Dipleura; Genus—Phacops; Genus—Reedops.

The most common trilobite remains are segments discarded during molting, and fossils in the rolled position. Careful observation and luck will turn up flat, whole trilobite casts and molds that range in size from 1.5cm to 23 cm.

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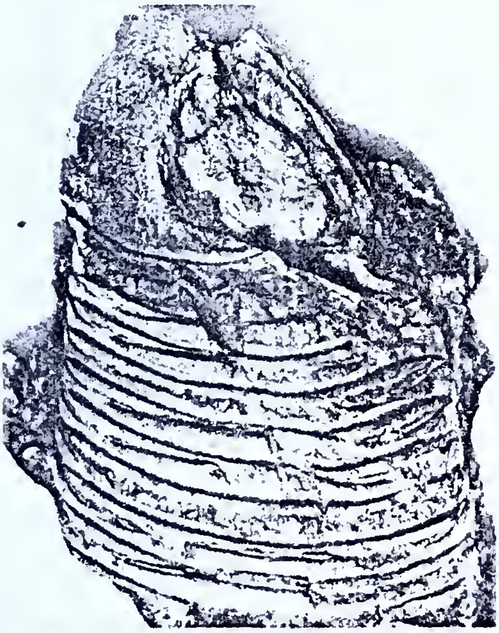
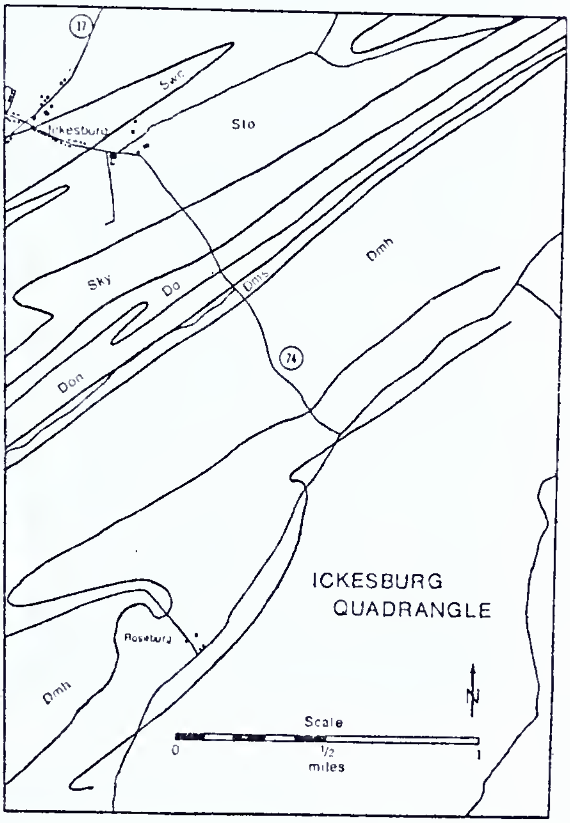


A rare find, a large cast of part of the thorax and pygidium of the trilobite Dipleura from the Sherman Ridge Formation, Perry County.



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THE ASHCRAFT LIMESTONE MOUND

by S. A. Krajewski & R. J. Cuffey

Upper Devonian rocks of northeastern Pennsylvania are mostly sandstones, siltstones and shales. However, the Ashcraft quarry located near the village of Little Meadows (Figure 1) in northwestern Susquehanna County, Pennsylvania, exposes an unusual limestone deposit.

The limestone exposed in the quarry (Figure 2) is approximately 15 feet thick and 700 feet wide. From drill core data, it was determined that the deposit is about 3000 feet long (Figure 3). The bottom contact of the limestone is flat and rests conformably on top of a gray shale. The limestone consists of a series of overlapping, inclined lenses which are 10 feet thick and 200 feet wide. These lenses are orientated with their long axes parallel to the long axis of the deposit, and dip to either side of the deposit's axial trend at 15°. Fossils found in the limestone are relatively sparse and are usually broken fragments of plants, brachiopods, pelecypods, gastropods and occasional vertebrate bones. The overburden, resting conformably on top of the convex upper surface of the limestone, is a 30 foot sequence of black and olive-brown shales which contain several kinds of fossilized worm tubes and burrows. Occurring near the top of the shale sequence are numerous asymmetrical siltstone lenses that are up to 3 feet thick and have a layer of broken crinoid stems at their base. Above the siltstones is a 1 to 3½ foot layer of cross-bedded sandstone.

Each of the individual limestone lenses within the quarry consists of three distinct parts: a lower half which is cross-bedded with shell debris, an upper massive half formed from suspended sediment, and a topmost, thin veneer of shelly material. The carbonate content of the lenses was provided mostly from shells which were brought in from off-shore, shell-strewn sand bottoms, or derived locally from invertebrates already inhabiting the mound area. The general characteristics of each of the lens parts are illustrated in Figure 4. After deposition, the sediments in the shell lenses were lithified by the solutioning of the invertebrate shells, and, the subsequent reprecipitation of sparry carbonate around the silicate and organic components of the lenses.

The following interpretation is offered for the origin of the limestone deposit. The close of the Devonian Period in North America

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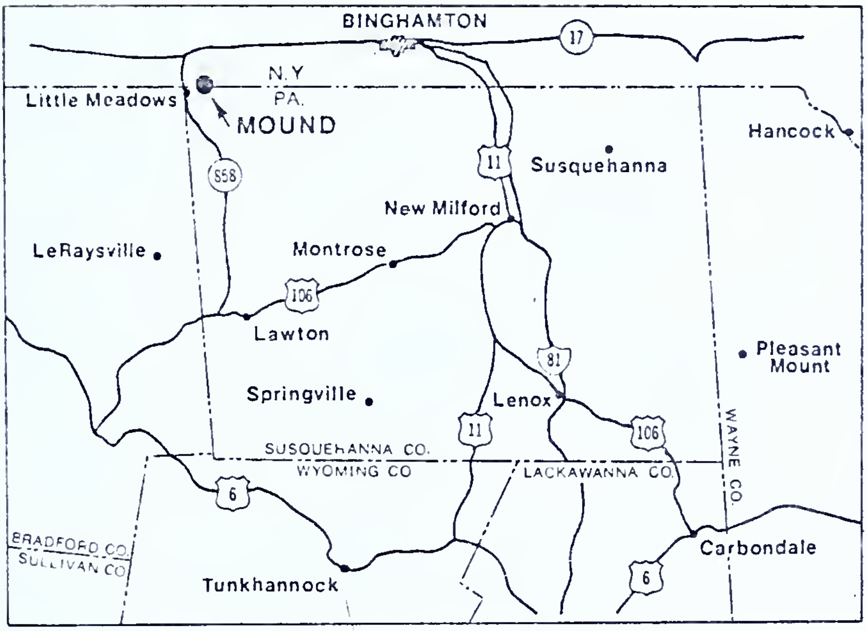

Figure 1

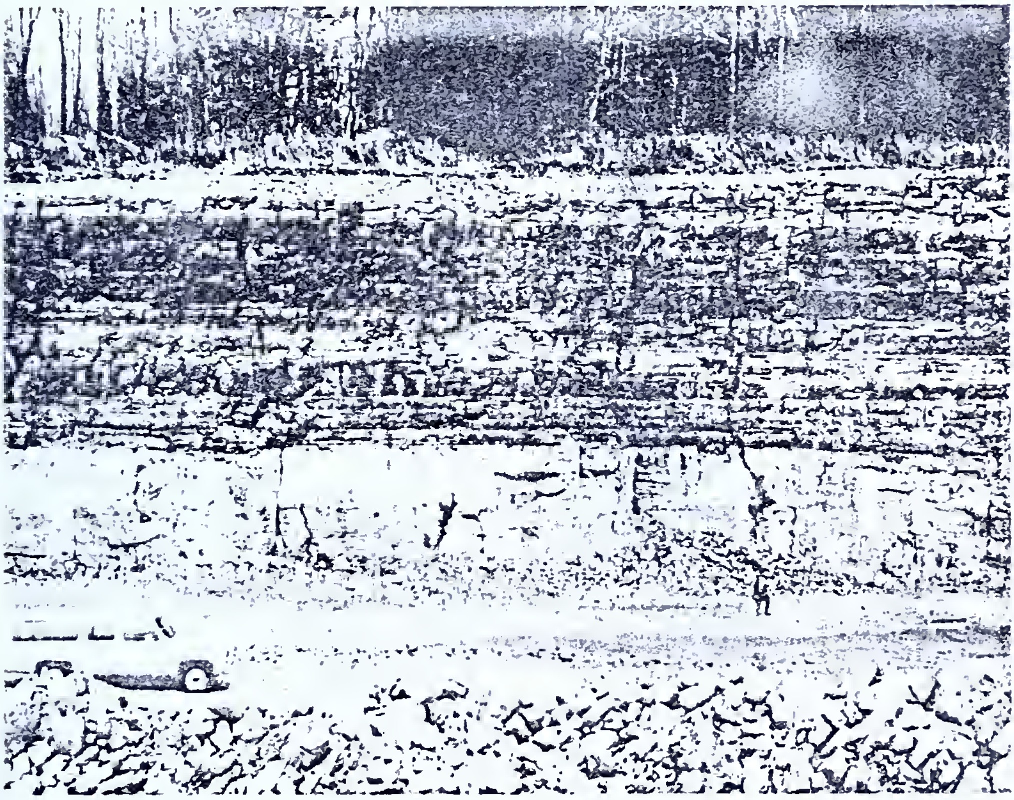

Figure 2

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was marked by uplifting throughout much of the eastern United States and Canada. Rivers draining the newly formed Acadian Mountains actively built complex delta systems into the subsiding Appalachian Basin. As these environments moved westward, they left behind a sequence of interfingered sandstones, siltstones and shales. These were the result of a deltaic environment that existed in the area during the close of the Devonian. It is thought that the limestone deposit formed in the area in front of the delta as is indicated in the paleogeographic sketch (Figure 5).

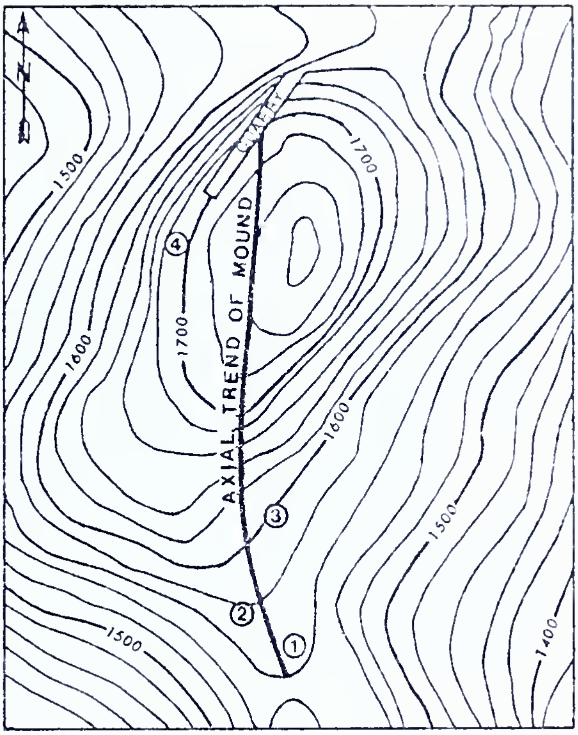

Figure 3

The fossils found in the limestone provide the key to the origin of the deposit. They imply a marine environment of deposition. Since the limestone contains only a low diversity of fossil invertebrates and no fully marine types such as crinoids, the water in which the limestone was deposited appears to have been somewhat brackish. The nearshore, brackish setting is further indicated by the presence of much sand, silt, clay, shale-chip interclasts, and large plant fragments mixed in with the shells. Finally, since the limestone contains only the above invertebrates but no corals or bryozoans, the deposit appears to represent a shell-mound rather than a framework-type reef.

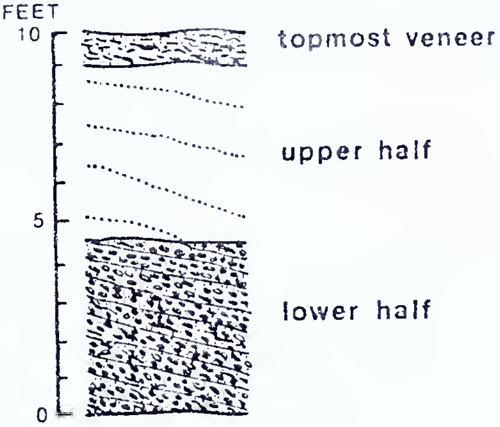

Figure 4

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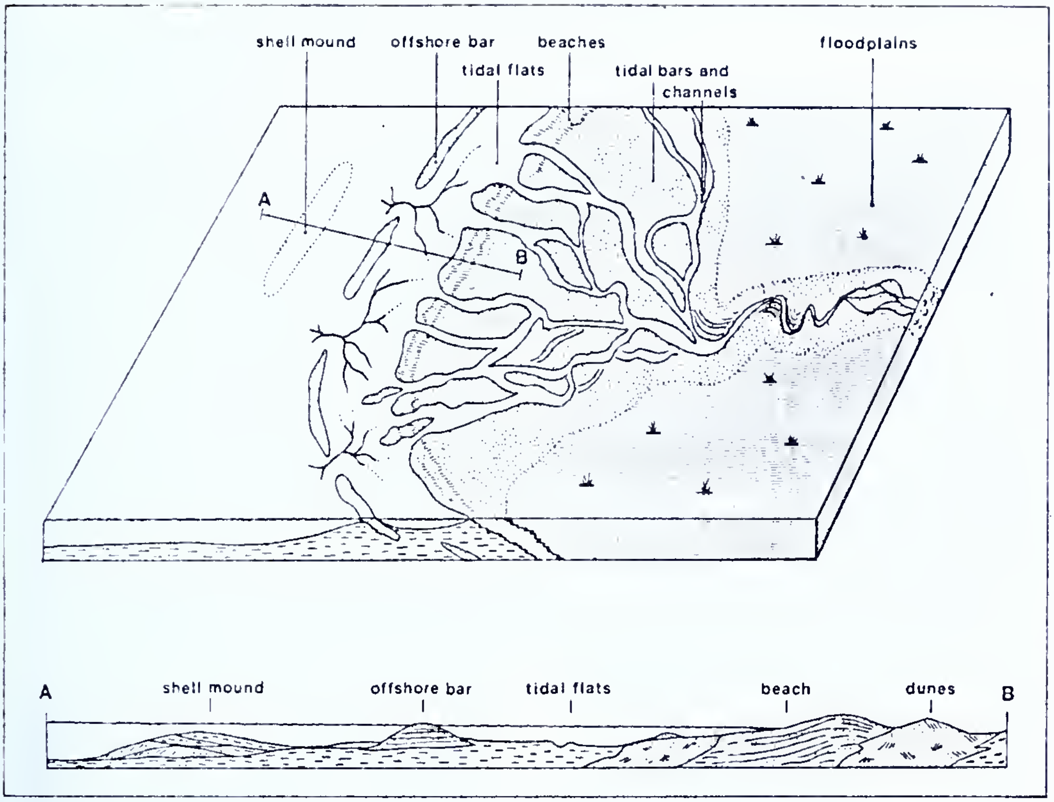

Figure 5

The paleoenvironmental analysis of the Ashcraft limestone mound has more than just academic importance. The mound is currently being quarried as a source of riprap and aggregate. The accurate description and interpretation of the origin of the mound, its compositional and textural characteristics, and its spatial geometry will ensure the efficient quarrying of the limestone. It was determined from outcrop and drill core data, and confirmed by strike and dip measurements, that the initial quarrying operation exposed an end of the mound (Figure 2). Additional observations enabled the delineation of an axial trend and subsurface extent of the mound. Using this data, it is estimated that there are approximately 500,000 cubic yards of recoverable aggregate in the mound. With its strategic location close to the metropolitan area around Binghamton, New York, the limestone mound should continue to provide the area with a valuable source of industrial minerals for future growth.

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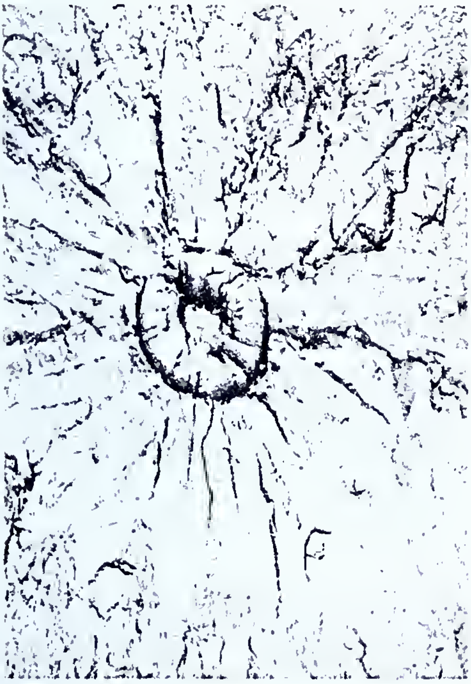
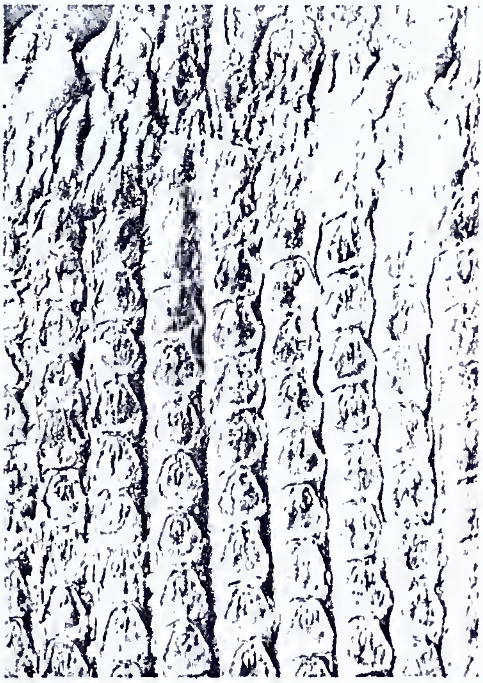
Edward S. Jones Fossil Plant Collection Curated –

by William F. Klose II

The Mineralogical Society of Northeastern Pennsylvania has undertaken the curation of the Edward S. Jones Collection of Rocks, Minerals and Fossils for the Lackawanna Historical Society in Scranton, Pennsylvania. The first section of the collection cleaned, identified, numbered, and cataloged consists of 140 exceptional Pennsylvanian Age Fossil plants collected from coal mines in the Scranton area between 1900 and 1920. Included are magnificent display slabs of the Lycopod Barks *Lepidodendron modulatum* Lesquereux, *Sigillaria mammilaris* Brongniart, *Sigillaria laevigata* Brongnart, and *Sigillaria reniformis* Brongniart, the Lycopod Cones *Lepidostrobus oblongifolius* Lesquereux and *Lepidocarpon lineari-folium* (Lesquereux), the Lycopod root, *Stigmaria ficoides* Sternberg, the Lycopod Branch Scars *Caulopteris* and *Ulodendron puntatum* Sternberg, the Sphenophyllid *Sphenophyllum emarginatum* Brongni-



Horizontal section of Lycopod cone *Lepidostrobus oblongifolius* on shale from near Scranton, Pennsylvania. Edward S. Jones Collection #J120. Photo by H. Michaels.



Lycopod bark *Sigillaria mammilaris* Brongniart from Olyphant, Pennsylvania, illustrating characteristic aberrant scars (at top) Edward S. Jones Collection #J43. Photo by H. Michaels.

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art, and the seed ferns *Alethopteris serlii* (Brongniart), *Mariopteris nervosa* Brongniart, *Neuropteris clarksoni* Lesquereux, and *Pecopteris* to name a few.

Edward S. Jones was the youngest child of Edward Jones, a pioneer Scranton Area Coal Mine operator and banker. After graduation from Wyoming Commercial College in Kingston, Pennsylvania, Edward S. Jones became Assistant Manager of the Archbald Mines and upon the death of his Father, General Manager of Jones, Simpson and Company, the mines' owner. In the years to follow Mr. Jones became a well known and respected Banker, Coal Mine Operator, Capitalist, Business Leader, Philanthropist, world traveler, and Lecturer. He kept his rock and fossil collections on display at his home Tyn-y-vron at Blakely, Pennsylvania, until his death in 1947. The collection was then transfered to the Lackawanna Historical Society at 232 Monroe Street in Scranton, Pennsylvania, where a small portion has been on display since.

It is indeed fortunate for us that through the thoughtfullness of men like Edward S. Jones some of the relics of our early coal mining era have been preserved for future generations to see, study, and enjoy.

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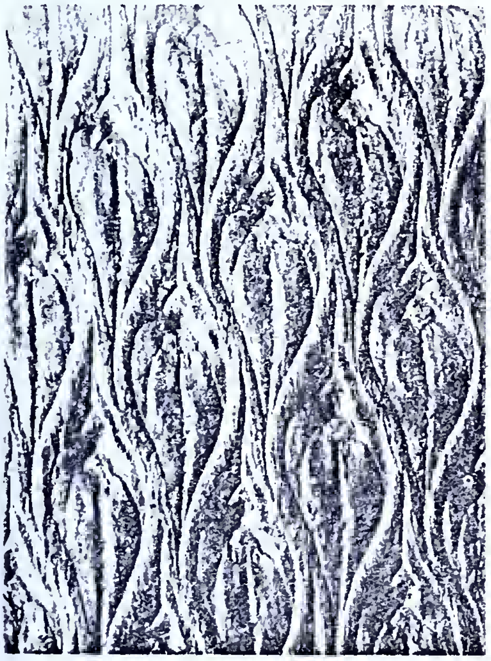

Lycopod bark *Lepidodendron modulatum* Lesquereux from Olyphant, Pennsylvania. Edward S. Jones Collection #J80. Photo by H. Michaels.

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MEET THE STAFF...

Bernard J. O'Neill, Jr., Chief
Mineral Resources Division

Bernard "Buck" O'Neill, Jr. joined the Survey Staff as an economic geologist in 1972, and on January 2, 1975 was appointed to the position of Chief of the Mineral Resources Division. His current responsibilities include planning and supervising regional and statewide geological investigations and evaluations of mineral resources in the Commonwealth.

Besides planning and guiding the Division, Buck has been involved actively in numerous projects dealing with Pennsylvania's non-metallic minerals, commonly referred to as industrial minerals. During the past few years his attention has focused on some important industrial mineral commodities – sand and gravel, crushed stone, clay and shale, and the carbonate rocks (limestone and dolomite). Recent publications by the Bureau of Topographic and Geologic Survey which report the results of his work include "Greater Pittsburgh Region construction aggregates" (1974), and "Potential high-calcium limestone resources in the Mt. Joy area, Lancaster County, Pennsylvania" (1975). In press are two other reports which cover: (1) properties and uses of clays and shales in the Greater Pittsburgh region, and (2) the distribution of limestones containing at least 90 percent $CaCO_3$ in Pennsylvania.

Before joining the Pennsylvania Geological Survey in 1972, Buck gained valuable experience in industry by working as Chief Geologist for the Foote Mineral Company, and as exploration geologist, mine geologist, and as mine supervisor for The New Jersey Zinc Company. He was employed also as a staff geologist with the Earth Sciences Department at Stanford Research Institute in Menlo Park, California. His work portfolio shows that he has done geological work in at least 20 states of the United States as well as in Venezuela and Brazil in South America, and in different provinces of Canada.

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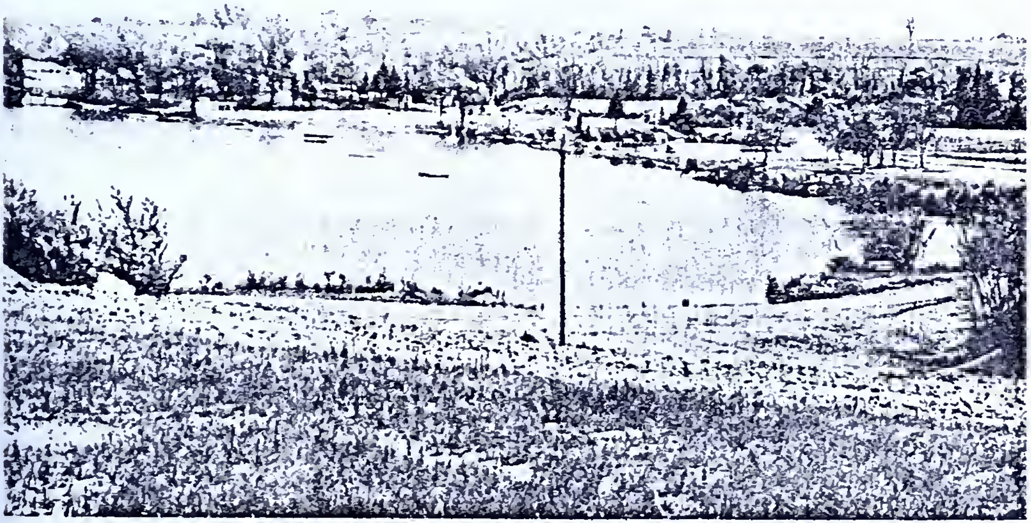
Buck was born in Paterson, New Jersey, obtained his B.S. degree in geology from Franklin and Marshall College in Lancaster, Pennsylvania, and his M.S. degree in geology from the California Institute of Technology in Pasedena, California. He is a member of numerous professional organizations including the Geological Society of America, the Society of Economic Geologists, and the Society of Mining Engineers of AIME.

A most interesting hobby that he enjoys during the November-March period each year is curling — the old Scottish game played on ice with stones and brooms. According to Buck, curling is a great sport for geologists because one really learns how to handle stones.

Multiple Land Use

An excellent example of multiple land use can be found in Lebanon County, Jackson Township, near the village of Millardsville where an abandoned quarry in the Annville Formation has been turned into a private swim club. The former Millards Quarry is also used by SCUBA divers for training and practice sessions. The Annville Formation is a high-calcium limestone which is a valuable source of pure limestone for the manufacture of cement, blast furnace flux, chemical lime and agricultural lime.



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TOPOGRAPHIC AND GEOLOGICAL SURVEY
Arthur A. Socolow, State Geologist

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ON THE COVER: *Bifungites*, an unusual trace fossil collected from the Late Devonian Girard Shale near Erie, Pennsylvania. Photo by R. C. Gutschick. See story page 2.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

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DECEMBER 1976

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

IS ANYBODY LISTENING?

Several years prior to the disastrous Alaskan earthquake of 1964 the U. S. Geological Survey published a report which pointed out that the ground conditions of the Anchorage area could result in serious earthquake damage. Despite the warning, development continued; no zoning or building restrictions were imposed. The earthquake came and disaster resulted.

For years, the location and implication of the active San Andreas fault of California has been known and publicized by geologists. Yet even as scientists and the public engage in speculation as to when the "big quake" will hit California, housing developments, schools, and various other structures are being built astride or in close proximity to the fault zone.

Many years age petroleum geologists pointed out that the rate of consumption of oil in this country was rising far more quickly than the rate of discovery of new petroleum resources, and that could only result in increased imports. The Arab oil embarge of 1973 was a jolting reminder that we had reached a level of imbalance wherein the United States was dependent on imports for 30% of its petroleum needs. Even with that penetrating reminder, today we are even worse off, importing some 42% of our petroleum needs.

Coming closer to home, geologists and hydrologists have been pointing up some of Pennsylvania's geologic problems. In western Pennsylvania the continuing landslide hazards are being documented by a series of U. S. Geological Survey maps showing landslide-prone areas. Subsidence-prone, mined out areas of western Pennsylvania have been documented on maps issued by the Pennsylvania Geological Survey. In central and eastern Pennsylvania, to supplement the message of Agnes and Eloise, hydrologists have issued flood-prone area maps and are stressing the point that so-called 100 year floods can occur even two years apart, or less.

The geologists, the hydrologists, and the other earth scientists have a message. Is anybody listening?

Arthur A. Socolow

Double–Arrow Trace Fossils in Northwestern Pennsylvania

by Richard Lamborn[1] and Raymond Gutschick[2]

Back in Late Devonian time, some 350 million years ago, Pennsylvania was inundated by shallow marine water and mud and sand sediments of the Catskill delta system were accumulating seaward in a westerly direction. Pennsylvania was in a tropical climate; seaward from the great delta, the open water was teeming with marine life. This is the scene of our story. "Double-arrow" describes the fossil trace (cover photo) made by some unknown animal that lived in this marine environment.

The genus *Bifungites,* literally "double-toadstool", was assigned in 1940 by Professor Ardito Desio of Milan to a "very curious fossil with the characteristic shape of a dumbbell" which he found in Late Devonian strata in Libya. *Bifungites* was recognized in 1962 (Gutschick and others) in Late Devonian rocks of southwestern Montana where it has wide distribution. Unidentified specimens of this trace fossil were in collections of the Pennsylvania State Museum that were acquired prior to 1940, but it was not until 1965 that Grant E. Kimmel of the U. S. Geological Survey found *Bifungites* while mapping Early Mississippian rocks in Mercer County. Kimmel discovered "double ended arrows connected by a shank from 1 to 2 inches long". In 1971, Lamborn found a specimen in Crawford County which looked like a pair of prominently barbed arrows connected by an inch long shaft. This find set in motion what was destined to be a long-continuing chain of events in the search and study of *Bifungites* in Pennsylvania. Specimens from Pennsylvania were compared with those from Montana, and the information was presented at the May, 1974 regional meeting of the Geological Society of America at Kent, Ohio, with full documentation published in October, 1975.

A wide variety of the burrow trace fossil, *Bifungites* Desio 1940, has been found in northwestern Pennsylvania. The form of the burrow casts is an inverted pi-shape (∐) indicating that two vertical

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[1] 3920 Cochran St., Erie, Pa.

[2] Dept. Earth Sciences, U. of Notre Dame.

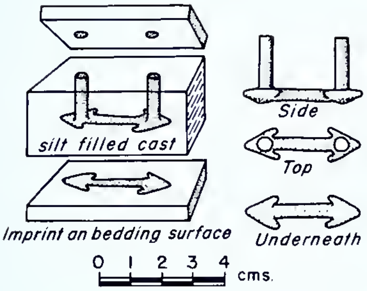

Figure 1: *Bifungites* burrow—generalized diagram.

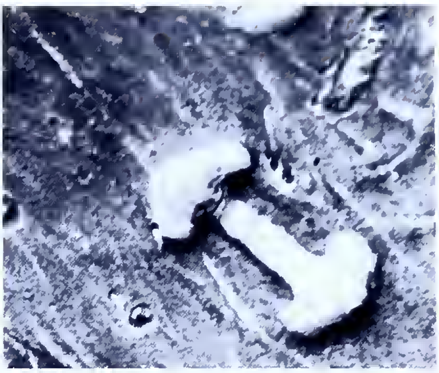

Figure 2: *Bifungites* from the Girard Shale.

cylindrical tubes connected the sediment-water interface to the basal portion of the burrow (Fig. 1). The horizontal basal portion is linear and has lateral terminations which project beyond the bases of the vertical tubes. These lateral terminal extensions are predominantly arrow-shaped, although dumbbell and irregular dogbone-shaped terminations also occur. One seldom finds a specimen in the field exposing the entire ㅛ-shaped burrow structure. By far, the more common occurrence is the double-arrow form.

Three major stratigraphic zones bearing *Bifungites* have thus far been identified in northwestern Pennsylvania. The oldest zone is in the Girard Shale, a formation of Late Devonian age approximately 850 feet below the Devonian-Mississippian boundary. Exposures of the Girard are found in roadcuts and along several of the streams in the vicinity of Erie. Specimens in this zone are plentiful but small (Fig. 2), typically about one half inch long. Additionally, the terminations of the basal portion of the burrow tend to be more rounded than those from the two younger zones. One of the more accessible collecting sites in the Girard is on a talus slope on the north side of Gore Road, approximately 100 feet from its intersection with Pa. Rt. 505 (driving southbound on Rt. 505, Gore Road is the first left turn beyond West 41st Street, Erie).

The second stratigraphic zone is in the Riceville Shale, which is the uppermost Devonian formation in northwestern Pennsylvania. The age, shape, and size of the Riceville *Bifungites* are essentially the same as those occurring in Africa and Montana. The Riceville traces are typically about one and one-quarter inches long (Fig. 3). Although there are a number of collecting sites in southern Erie County and in Crawford County, none has yielded large numbers of specimens.

The third and uppermost stratigraphic zone is in the Meadville

Shale, a formation of Early Mississippian age, approximately 300 feet stratigraphically above the Devonian-Mississippian boundary. Exposures occur in steep-sided gorges and creek beds at many localities in Crawford, Mercer and Venango Counties. Specimens are plentiful, typically one and one-half inches long, and consistently of the double-arrow shape with prominent barbs on each end of the shaft. (Fig. 4). The contrast in texture and color between the darker traces and the lighter matrix, especially when wet, imparts a spectacular appearance. The best material for preparing sectioned specimens to show the pi-shaped burrow structure (Fig. 1) has been found near the city limits of Meadville, along Cemetery Run at the bottom of the hill, east of the large water tower on Limber Road. Specimens from the Sharpsville Sandstone are similar to those in the Meadville and are considered of that type.

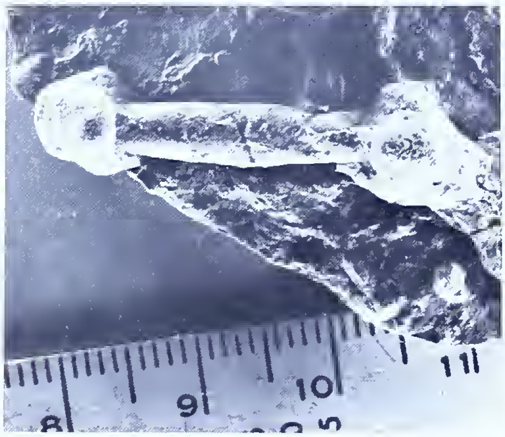

Figure 3: *Bifungites* **from the Riceville Shale.**

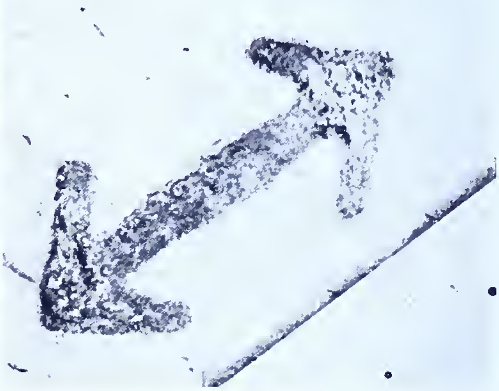

Figure 4: *Bifungites* **from the Meadville Shale.**

During 1975 a number of new collecting sites were discovered as more individuals became interested in *Bifungites*. Six new finds were made in Elk County alone, all relatively close to the Clarion River, West Branch. Other counties with at least one new collecting site include Carbon, Clearfield, Clinton, Erie, and Westmoreland. The list will undoubtedly continue to grow, and search will be directed to fill in and extend the stratigraphic range of *Bifungites*.

Trace fossils are very useful and they provide insight into the paleoenvironmental conditions of sedimentation. There is some suggestion of systematic change in *Bifungites* form through geologic time which may be helpful in the recognition of different formations. The organism responsible for *Bifungites* traces is undetermined but it was probably a small sedentary, soft-bodied, suspension-feeding invertebrate animal inhabiting shallow, nearshore marine and brackish-water muds and sands found in estuarine marches, tidal flats, delta platforms and bar margin areas. A few brachiopods and clams, as well as some other trace fossils are the only faunal associates of *Bifungites* observed in Pennsylvania.

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SURVEY ANNOUNCEMENTS

CLAY AND SHALE RESOURCES OF THE GREATER PITTSBURGH REGION

The results of studies concerning the economically-important clay-shale resources in the Greater Pittsburgh Region as undertaken by the Pennsylvania Geological Survey in cooperation with the U. S. Department of Interior — U. S. Geological Survey and U. S. Bureau of Mines — are presented in the new publication, Mineral Resources Report 71, titled "Greater Pittsburgh Region — Properties and Uses of Clays and Shales" by Bernard J. O'Neill, Jr.

Data are summarized for 383 clay-shale samples that were collected from stratigraphic units within the Pennsylvanian, Pennsylvanian-Permian and Quaternary Systems, and includes information concerning location of sample, thickness, type of material, unfired and fired properties, chemical analyses, and current or potential uses based upon test results. Evaluations indicate that 331 of these samples have a potential for one or more of the following uses: common brick, face brick, floor or paving brick, architectural or decorative brick, drain tile, sewer pipe, vitrified liner plates, structural facing tile, non-load bearing structural tile, stoneware, fireproofing, refractories, and lightweight aggregate.

The results of correlation studies are presented also. Correlations were made to determine: (1) the relationship of type of raw material and use; (2) the relationship between each type of material within each geologic group and use; and (3) whether a relationship between chemical analyses and use as a lightweight aggregate material existed.

Mineral Resource Report 71 may be purchased for $3.70, plus 6% sales tax if mailed to a Pennsylvania address, from the following agency: State Book Store, General Services, 10th and Market Streets, P. O. Box 1365, Harrisburg, PA 17125.

THE DISTRIBUTION OF HIGH-CALCIUM LIMESTONES IN PENNSYLVANIA

Mineral Resource Report 50, Part 4 is a guide to geologic units in Pennsylvania that have the best potentials to be economic sources of limestones containing a minimum of 90% $CaCO_3$. The distribution of these limestones is shown on a 1:500,000 scale map with important information concerning their stratigraphic position, thickness, and chemistry presented in tables. The exploration potential for these limestone units is color coded into a twofold division on the map and is based upon: (1) variations in the quality of limestone units, both laterally and vertically; (2) the quality of limestone unit as reported by analyses; (3) whether the unit is represented by a minable thickness; and (4) past record of production.

The information presented in this publication should be of particular interest and applied use to those who are in search of limestones for use in the desulfurization of flue gases at power plants or other types of plants that emit SO_2. It should also prove useful to producers, consumers, and researchers who are concerned with high-calcium limestone resources.

Mineral Resource Report 50, Part 4 by Bernard J. O'Neill, Jr. is available for $1.15, plus 6% sales tax if the publication is to be mailed to a Pennsylvania address, from the following agency: State Book Store, General Services, 10th and Market Streets, P. O. Box 1365, Harrisburg, PA 17125.

The Geological Society of Pennsylvania 1832-1836

by Anne Millbrooke

Part 1: Founding the Society

The institutionalization of science in government is a complex question involving politics, personalities, and ideologies of science. During the nineteenth century American scientists worked predominately in natural history — identifying and studying the land and life of the New World. It is no wonder then that the first science supported by many states was natural history, particularly geology. North Carolina established the first state geological survey in 1823, and South Carolina the second in 1824. Both surveys were short lived. In 1830 Massachusetts instituted a survey, followed by Tennessee (1831), Maryland (1833), New Jersey (1833), and Connecticut (1835). Four states — Maine, New York, Ohio, and Pennsylvania — established surveys in 1836. By 1850 twenty states had or had had state geological surveys.

Reasons given for the establishment of state surveys vary from internal improvements to education and from availability of personnel to the personalities of individual geologists. In the case of Pennsylvania a group of gentlemen associated in the Geological Society of Pennsylvania actively promoted the establishment of a state survey. Advancing the usual economic and educational arguments, the membership of the Geological Society was the driving force behind the establishment of the Pennsylvania survey. When the survey was established in 1836, the Geological Society, then an organization with over two hundred members, collapsed. Why? What is the story of the Geological Society of Pennsylvania? What was its role in the establishment of a state survey? The answers to these questions lie in the origin of the society, its membership, its publications, and the economic and political situation in the state.

The only history of the Geological Society of Pennsylvania is that by J. Peter Lesley in his 1876 *Historical Sketch of Geological Explorations in Pennsylvania and Other States.* Lesley was a geologist writing history of geology for geologists. At the time his *Historical Sketch* was published, Lesley was state geologist for the Second Geological Survey of Pennsylvania, and his sketch was a publica-

*4615 Spruce St., Philadelphia, Pa.

tion of that survey. Although Lesley's account of the Geological Society contains much factual information, it is neither complete nor entirely accurate.

The earliest documentary evidence available concerning the Geological Society of Pennsylvania is an address given in 1826 by Peter A. Browne, a Philadelphia lawyer with an interest in science. The purpose of Browne's address was to promote a geological and mineralogical survey of Pennsylvania. Given in September at a public meeting held at the Franklin Institute, the address opened with an acknowledgement of the newness of interest in geology and mineralogy. Browne cited the case of a Mr. Cooper who was charged with lunacy for his mineralogical excursions as late as 1811.

> Happily, [Browne continued] since that period, the cloud has been dispelled, and at this enlightened day there are few, if any, places in the commonwealth, where the student of nature may not travel on foot, with his hammer, and glass, in his hand, without incurring an imputation upon his understanding.[1]

Browne further pointed out that there were good reasons for studying geology and mineralogy, such as the pleasure of repairing to the fields, the satisfaction gained from the knowledge, and the discovery of valuable minerals "hidden from vulgar eyes."

The establishment of a state geological survey, Browne claimed, would help the agriculture, education, and manufactures of the state — particularly the manufactures. As he said, "Pennsylvania is destined to be a manufacturing country; in iron and coal, her resources are exhaustless, and her water power is immense; and there is nothing better calculated to assist our growing manufactures, than this survey . . . "[2] The proposed survey would take five years and cost an estimated $3,000 per year. The state would be divided into twenty-six districts, and each district would be mapped. Geological and mineralogical collections — one for the state and one for each county — would be made for display in public places, where students could study the specimens. The collection work would cost $5,000. Preparation and publication of the maps and of an accompanying volume of explanatory notes were to be finished within one year of the completion of the survey and cost $20,000. In all, the survey would take six years and cost about $40,000. Browne proposed to do the survey and related work himself.

Browne's 1826 address was not his first proposal to make a geological survey of Pennsylvania, but it was the first time that he received encouragement. The citizens meeting at the Franklin Institute responded favorably to Browne's address by appointing a committee to study the proposition. In addition to Browne, the committee consisted of C. C. Biddle, Robert M. Patterson, Henry S. Tanner, E. S. Burd, Stephen Duncan, Gerard Ralston, and John Wurts — lawyers and businessmen, not geologists. Browne's proposal also received support from outside the meeting. *Niles' Weekly Register,* a newspaper, reported that "the advantages of the survey are well set forth in the address, and we hope it will receive that attention which we think it deserves."[3]

When the committee on Browne's proposal reported in December, the cause of science received only passing mention. Economics dominated the report. The committee members had, according to their report,

> no hesitation in declaring their unanimous opinion, that, in case proper encouragement be afforded to this laudable and magnificent design, the cause of natural science will be greatly advanced; the values of lands, at present apparently useless, will be fully developed and incalculably increased; important aid will be afforded to the grand system of internal improvement; the manufacturing and agricultural interests of the country will be essentially promoted; and the whole commonwealth enriched, and most materially and beneficially affected, in her various and most interesting relations.[4]

The "proper encouragement" necessary for the survey was individual *and* legislative patronage; the state survey was of a scale too large to be privately financed. The committee members, in addition, felt that the geological surveying of 45,000 square miles was of a scale too large for one man, so they modified Browne's proposal to include assistants — two for the surveying and one for the maps.

A new committee of twenty-five was appointed to implement the revised plan, and the *Journal of the Franklin Institute* reported that a society under the name of "Geological Society of Pennsylvania" was about to be organized and that "many of our most scientific fellow citizens are already enrolled in the list of members."[5] The Geological Society appeared to be launched, but nothing more was heard of it until 1832.

Why was the Geological Society of Pennsylvania not founded until 1832 when so much momentum was present in 1826 and 1827? The answer is Peter A. Browne.[6] Browne was the prime mover behind the movement for a state geological survey. He was also a lawyer and a promoter. During the early years of the Franklin Institute he had been active there, serving on the Board of Managers, the Committee on Lectures, the Building Committee, the Committee on Publications, and as corresponding secretary and as lecturer for two courses on geology. He was also an active member of the Academy of Natural Sciences of Philadelphia. In 1827 business matters distracted Browne from his various promotions of science, including the geological survey of Pennsylvania. With businessman Thomas P. Jones and architect John Haviland, Browne built an arcade on Chestnut Street between Sixth and Seventh Streets in 1826-27. Browne's arcade, the first arcade constructed in the United States, accommodated about eighty shops and the Peale museum. In 1828 Browne and Haviland entered upon another venture, a pagoda in North Philadelphia. The oriental pagoda, in conjunction with a labyrinth garden, failed to attract tourists and was destroyed shortly after being built. Neither the arcade nor the pagoda was a business success, but they earned P. A. Browne the nickname Pagoda Arcade Browne. More to the point, they diverted Browne's interest from the state geological survey. The support that Browne had engendered for the survey in 1826 was more a gesture than a reality. He had no real constituency as evidenced by the lack of activity towards a state survey or even a geological society while he was occupied with other matters.

In 1832 Browne again actively promoted a state geological survey, and with his renewed interest the Geological Society of Pennsylvania came into being. It planned public lectures and held meetings during its first year. The object of the Geological Society was clearly expressed in its constitution which called upon members "to contribute their individualexertions . . . to use their influence to have the state geologically surveyed . . . to assist in making a State Geological and Mineralogical collection . . . [and] to disseminate the useful information thus obtained."[7] The purpose was political: the members were to use their influence to have a state geological survey established; they were not to make such a survey. The political nature of the Geological Society was also reflected in the selection of officers. John B. Gibson, president, was chief justice of the state supreme court. Nicholas Biddle, vice president for the city of Philadelphia, was president of the United States Bank; and the vice president for the county of Philadelphia, Stephen H. Long, was an Army officer. Henry S. Tanner, treasurer, was an engraver and map maker; George Fox, recording secretary, was a physician; and Peter A. Browne, corresponding secretary, was a lawyer. The officers were all prominant men, but none were geologists.

Proceedings of the Geological Society of Pennsylvania were published in the *Monthly American Journal of Geology and Natural Science,* edited by G. W. Featherstonhaugh, an Englishman interested in scientific and political affairs. The *Monthly American Journal,* according to its prospectus, sought "to vindicate the natural history of America, and the reputation of American naturalists."[8]

It early published a circular from the Geological Society; the circular contained twenty-eight queries regarding the presence and quality of surveyors in each county or township, the kinds and quantities of minerals, the kinds and amounts of coal, the existence of mineral springs and natural caves. Like the Geological Society, the *Monthly American Journal* was political. Featherstonhaugh, the editor, felt that until state legislatures appreciate the importance of geological information, especially that pertaining to mineral and coal deposits, "it is for zealous individuals to draw the public attention to so great a subject."[9] The members of the Geological Society of Pennsylvania were such zealous individuals.

(to be continued)

NOTES

[1] Peter A. Browne, *An Address, Intended to Promote a Geological and Mineralogical Survey of Pennsylvania, the Publication of a Series of Geological Maps, and the Formation of State and County Geological and Mineralogical Collections* (Philadelphia: P. M. LaFourcade, 1826), p. 3.

[2] Browne, *Address,* p. 5.

[3] *Niles' Weekly Register,* 34 (2 December 1826), p. 212.

[4] "Geological Survey of Pennsylvania," *American Journal of Science and Arts,* 12 (1827), p. 175.

[5] *Journal of the Franklin Institute,* 3 (1827), p. 432.

[6] No biography of Browne (1782-1860) exists; a brief sketch is in Seldon J. Coffin, *The Men of LaFayette, 1826-1893; LaFayette College, Its History, Its Men, Their Record* (Easton, Pa.: George W. West, 1891), p. 113. For Browne's involvement with the Franklin Institute, see Bruce Sinclair, *Philadelphia's Philosopher Mechanics, a History of the Franklin Institute, 1824-1865* (Baltimore: Johns Hopkins University, 1974). Descriptions of Browne's arcade and pagoda are in George B. Tatum, *Penn's Great Town, 250 Years of Philadelphia Architecture Illustrated in Prints and Drawings* (Philadelphia: University of Pennsylvania, 1961).

[7] Geological Society of Pennsylvania, "Constitution," *Hazard's Register of Pennsylvania,* 9 (31 March 1832), p. 208.

[8] *Monthly American Journal,* 1 (July 1831), p. 3.

[9] *Monthly American Journal,* 1 (March 1832), p. 429.

serving the national defense

William S. Lytle, Chief of the Pennsylvania Geologic Survey's Oil and Gas Division and head of the Survey's Pittsburgh Branch Office, has been reappointed to another three-year term as a member of the Petroleum and Gas Unit of the National Defense Executive Reserve for the Department of the Interior. This important agency directs its attention to plans and procedures to be implemented in case of a national emergency.

ST. BARBARA -
PATRON SAINT OF MINERS

In a recent publication authored by Dr. Cedric E. Gregory, Visiting Professor of Mining Engineering at the Virginia Polytechnic Institute and State University, the fascinating legend of St. Barbara is brought to light. To the vast majority of people within our mining communities, the role St. Barbara has played over centuries in other parts of the mining world is unknown, and it is for this reason that we summarize it here.

The legend of St. Barbara dates back to the 3rd Century when she was executed by her outraged father for forsaking his Roman-Greek gods for Christianity. Immediately following Barbara's death, a terrible thunderstorm arose and her father was killed by lightning. Later, as Christianity became more firmly established, St. Barbara was looked upon as a Protectress against the perils of lighting. The belief had grown that she could control lightning and all other forms of fire and flame. Because miners were exposed to hazards involving powder which resulted in explosions similar to lightning, St. Barbara was adopted as the Patron Saint of Miners.

In all European countries endowed with mineral wealth, and particularly in regions where the economy depends so much upon mineral production, the Festival of St. Barbara, the Patron Saint of Miners, is celebrated each December 4. One of the worthy customs associated with each festival is the gathering of miners who indulge in some hearty drinking of ale.

St. Barbara is well represented in the arts. The drawing which accompanies this article was sketched from a photograph of a statue of St. Barbara in Huettschlag, near Salzburg, Austria. Copper ores were mined in Huettschlag from 1510 to 1863. Representations of St. Barbara appear also in the form of woodcuts (1415-1550), copper engravings (16th Century) and brush drawings; also in paintings and sculpture. Some scenes related to mining show St. Barbara floating on clouds, with winches, hoists and ropes below.

A detailed account of the Legend of St. Barbara is available for purchase at $1.25 per copy from the Division of Minerals Engineering, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.

HIGH CALCIUM LIMESTONE DISCOVERED IN THE WILLIAMSPORT – BLOOMSBURG AREA

by Rodger T. Faill

Extensive sampling along the West and North Branches of the Susquehanna River at quarries in the Tonoloway and Keyser Formations (Fig. 1) has resulted in the discovery of a new source of high-calcium limestone.

Air-quality emission standards proposed by the Federal Environmental Protection Agency for steam-electric power plants have resulted in a number of research projects designed to develop processes capable of removing sulfur oxides from flue gases of plants burning high-sulfur fuels. The most advanced and promising process under consideration involves wet scrubbers that use lime or finely ground limestone which is high in calcium carbonate. To help satisfy a long-term increasing demand for high-calcium limestone, the Bureau of Topographic and Geologic Survey has been involved in a cooperative program with the U. S. Bureau of Mines to improve our knowledge concerning the quality and quantity of limestones in Pennsylvania.

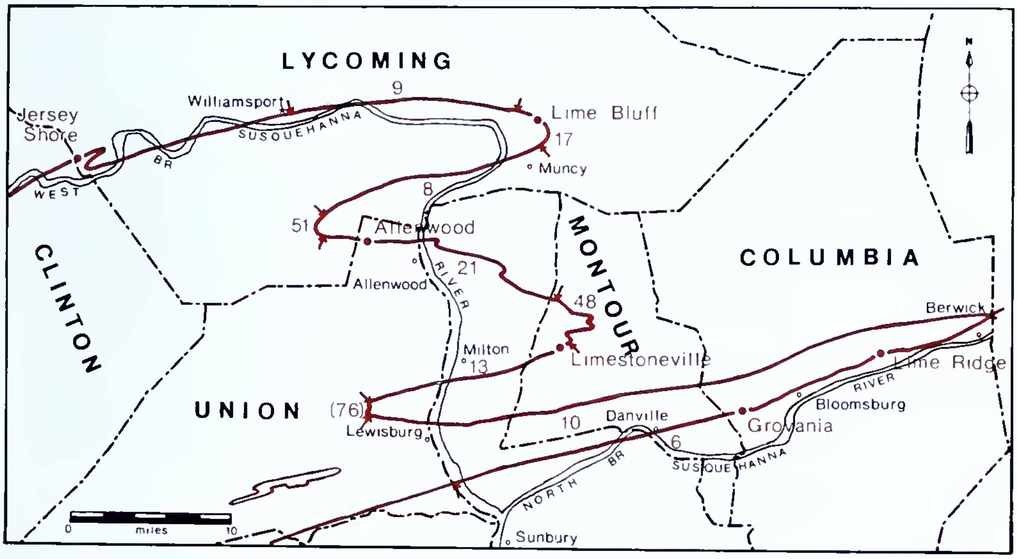


Figure 1: Map of upper Tonoloway and Keyser Formations in central Pennsylvania, with locations of the six sampled quarries. Numbers in color between tick marks represent approximate reserves of 90+ percent calcium carbonate limestone within 100 feet of surface, in thousand tons per 100 feet along the outcrop.

Between Williamsport and Berwick, a zone of birdseye micrite (very fine-grained limestone with numerous small patches of calcite crystals) overlies the laminated to platy limestones characteristic of the Tonoloway, and underlies the cobbly, argillaceous limestone beds of the lower Keyser. This zone, with calcium carbonate ranging from

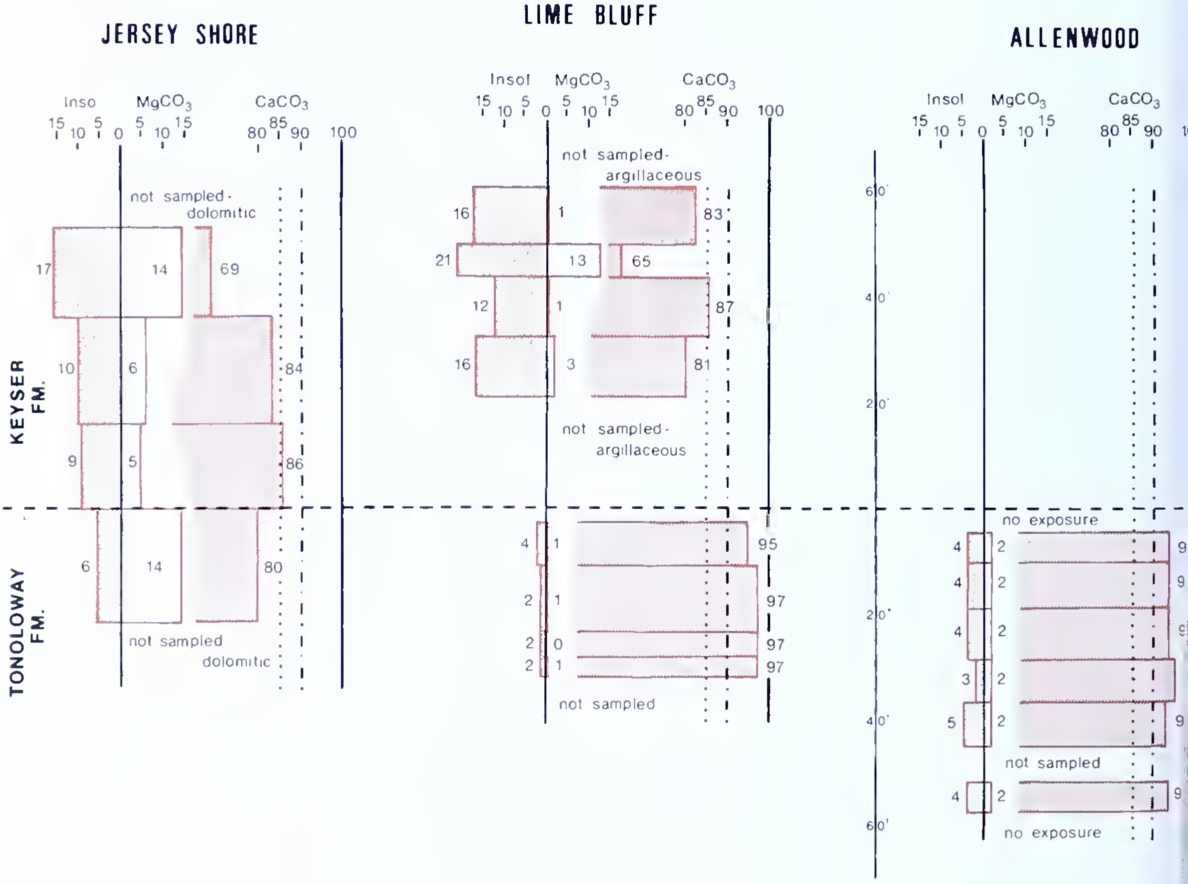
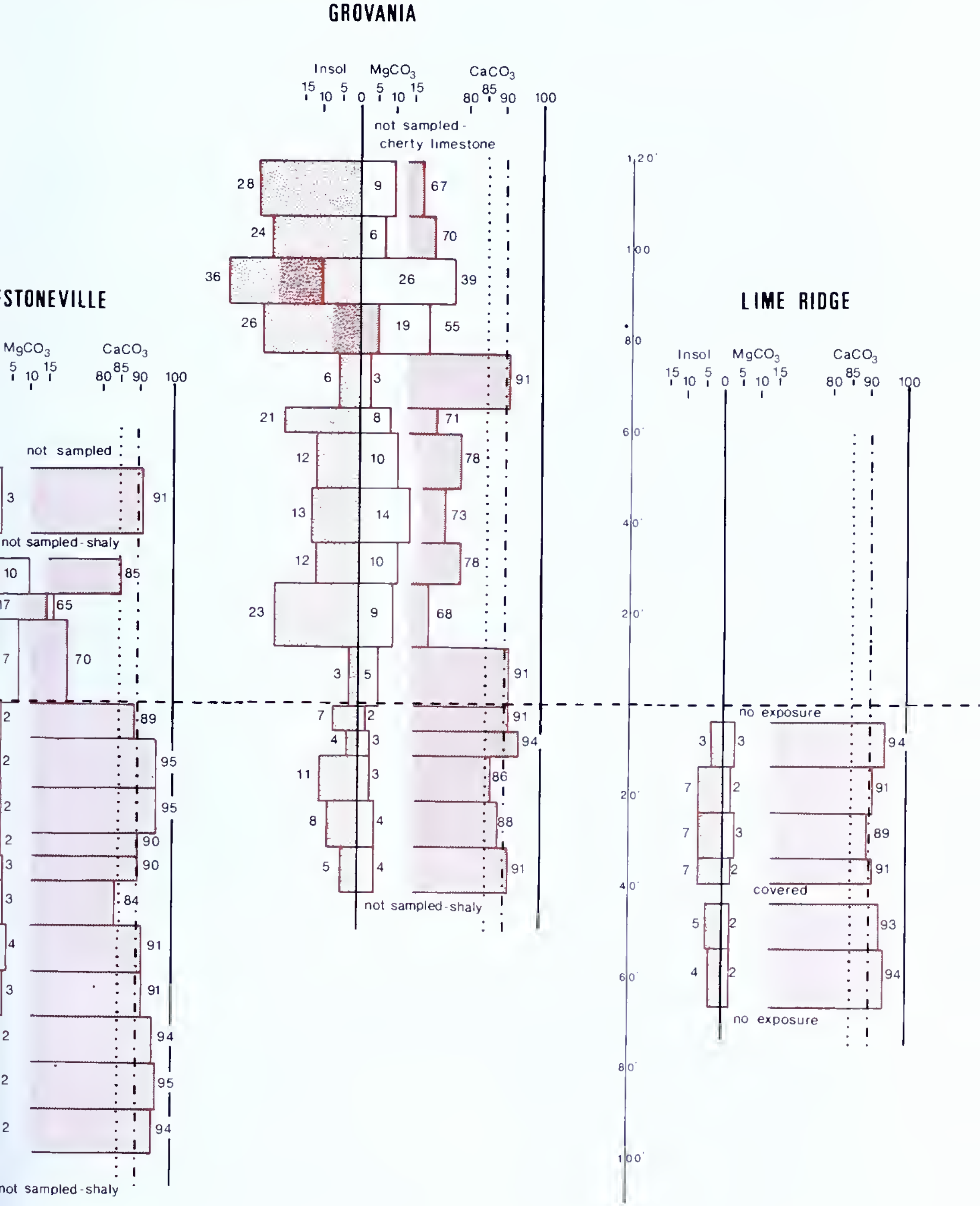


Figure 2: Correlated columns showing chemical analyses and thicknesses of sampled units. Hatching — $CaCO_3$; outline — $MgCO_3$; dotted — Insoluble Residue; numbers — percent composition, by weight. Zero for $CaCO_3$ scale does not coincide with zero for $MgCO_3$ and Insoluble Residue scales.



90 to 97 percent of the rock, extends eastward and southward from Williamsport. At Limestoneville, a second zone 50 feet below the top of the Tonoloway is also quite pure, with $CaCO_3$ ranging from 91 to 95 percent. (This part of the Tonoloway was not sampled at the other localities because of lack of exposure.) This upper high-calcium zone apparently does not extend west from Williamsport, because the birdseye micrite is not present at Jersey Shore — the Keyser directly overlies the laminated beds of the Tonoloway. The absence of these micrite beds is reflected by the lower $CaCO_3$ content of the sampled interval which these beds should occupy.

Units within the Keyser Formation generally have markedly lower $CaCO_3$ contents than those of the Tonoloway. The two principal exceptions are a 15 foot thick sequence in the middle of the Keyser at Limestoneville, and two 12 foot thick sequences at Grovania that have a $CaCO_3$ content of 91 percent, one in the middle and the other at the base of the Keyser. Although the calcium carbonate content of the Keyser is significantly lower than that of the Tonoloway, the Keyser beds were used for agricultural lime in the past because they burned much more readily than the purer, platy Tonoloway.

The folds in this region plunge to the east; therefore these high-calcium beds occur at and east of the sinuous outcrop pattern shown in Figure 1. Although these beds underlie much of this area, the beds are economically exploitable only where they are within 100 feet of the surface. The areas that would be most productive are where the beds dip the least, and this generally occurs in the fold noses, e.g., near Muncy, west of Allenwood, east of Milton and· northwest of Lewisburg. However, the beds around Berwick are covered with river gravels, which may be 25 or more feet thick — this much overburden would pose severe difficulties for quarrying.

Total minable reserves of limestones with more than 90 percent $CaCO_3$ along the entire outcrop belt from Williamsport to where the outcrop crosses the West Branch of the Susquehanna River just north of Sunbury — a distance of 69 miles — are approximately 100 million tons. The minable reserves per 100 feet along the outcrop belt are indicated in Figure 1. These figures are very approximate, but they do illustrate the concentration of reserves in the noses of folds. The relatively low value at Lime Bluff reflects the absence of analyses below the micrite zone — additional high-calcium beds may be present there as at Limestoneville. Inclusion of the limestones containing 85 to 90 percent $CaCO_3$ would increase these reserve figures by at least 50 percent.

The chemical analyses were done through a cooperative program with the U. S. Bureau of Mines. The complete analyses for all the samples from each quarry are available on microfiche cards from the Bureau of Topographic and Geologic Survey, free upon request.

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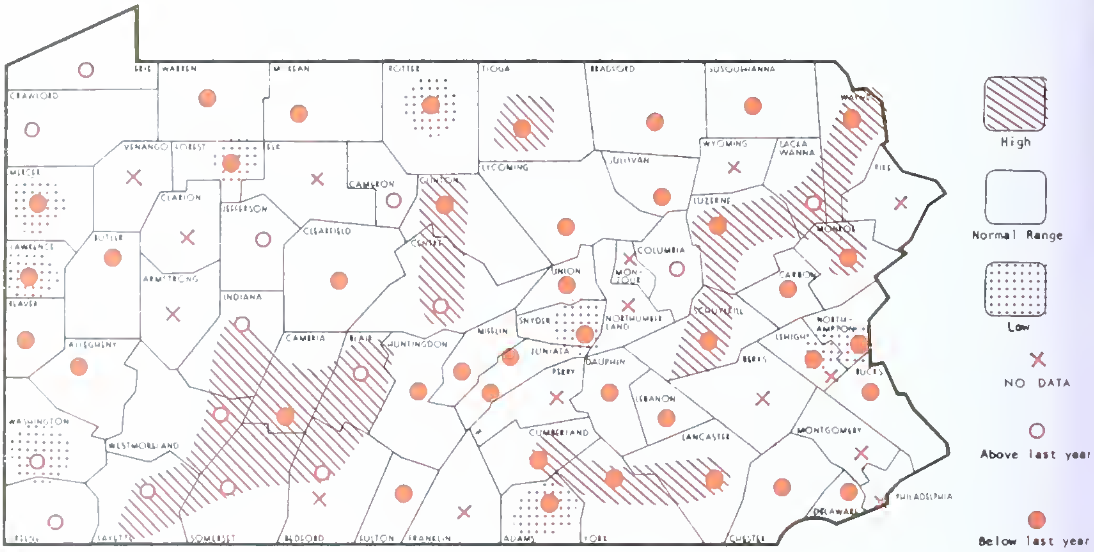

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ON THE COVER: The striking feature of Split Rock lends its name to the nearby Village of Split Rock in Carbon County. Formed by weathering and erosion along two parallel joints which cut the quartz-sandstone Duncannon member of the Catskill Formation, this natural gap is about 25 feet high and 6 feet wide. Photo courtesy of William Bolles.

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FEBRUARY 1977

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

THE MANY FACES OF GEOLOGY

It is fascinating to this writer to find how diverse is the impression amongst various individuals, including geologists, as to what the subject of geology is all about. I do not refer to those who simply have a preference or specialization in one aspect of the science, but rather to those who do not have an awareness of the many ramifications of geology and the variety of ways the subject relates to the lives of man: A review of the contents of this issue of our journal reveals some of the diversity of geologic applications.

The structural geology article on page 2 integrates observed Appalachian Mountain features with practical engineering design procedures imposed by the geologic conditions. On pages 6, 14, and 15 the reader is introduced to Pennsylvania's role as a major source of the energy resources coal, oil, and gas, along with the geologic procedures utilized in locating and defining the distribution of those vital resources. The role of geology in land use planning is demonstrated by the environmental geology reports and maps announced on pages 14, 15, and 16. The recreational aspects of geologic features are presented on pages 7, 9, and 15. The role of geology in helping to safeguard mining techniques is shown by the article on page 12. And on page 8, we find a description of how contemporary geologic theories are being integrated into our educational systems.

The office of the State Geological Survey is a focal point of every geological activity and event imaginable — and some that are unimaginable! They include basic scientific investigations, applied programs of critical mineral and water resources development, long-range land use planning guidelines, the crises of geologic hazards (such as landslides and sinkholes), as well as involvement in recreational planning (as mineral collecting and trail designs).

We hope that through the medium of this periodic journal, we are helping to make our readers somewhat more aware of the many and diverse ways in which geology relates to their daily lives.

Arthur A. Socolow

Structure and Engineering Geology at the Rockville Cut

by S. I. Root and J. P. Wilshusen

During construction of the River Relief Route north of Harrisburg a large excavation was made through Devonian Montebello quartzitic sandstones near the Rockville railroad bridge crossing of the Susquehanna River. This cut is interesting because of geologic structure visible on the face and the engineering geology of the rocks.

Several thrust faults inclined at low angles to the earth surface, offset dramatically contrasting light gray, dark gray, and dark brownish-red beds of sandstone that stand vertically (Figure 1). Offsets on the faults range from several feet (Figure 1) to less than one inch (Figure 2). However, fault geometry and mechanics are similar in both the largest and smallest faults. Faulting of this type was described in 1943 by E. Cloos and C. H. Broedel in a paper entitled "Reverse Faulting North of Harrisburg, Pennsylvania" which appeared in The Bulletin of the Geological Society of America. According to the authors, these faults occurred after the strata had been folded from their original horizontal position to their present vertical position. The stress that caused faulting was essentially directed horizontally and movement direction, as shown by fault striae or grooving, was perpendicular to the trend of the mountains. Net effect of faulting has been to produce a series of "wedges" that extend the rocks in a vertical sense and diminish the width across the rock layers (Figure 3). Total vertical thickening and lateral shortening may aggregate to several hundred feet in an area of several miles.

This faulting was the last effect of the large scale deformation that formed the Appalachian Mountains. Some 240 million years are estimated to have elapsed since the earth's crust in eastern North America was deformed into these scenic mountains.

The geologic features exposed in the new cut are not only of interest in what they illustrate about the manner of deformation during which the Appalachian Mountains were developed; they are of equal interest for their effect upon construction and development of the roadcut. The cut is large, 218 feet deep and 272 feet along the slope from top to bottom. The angle of slope is ¾ horizontal to 1

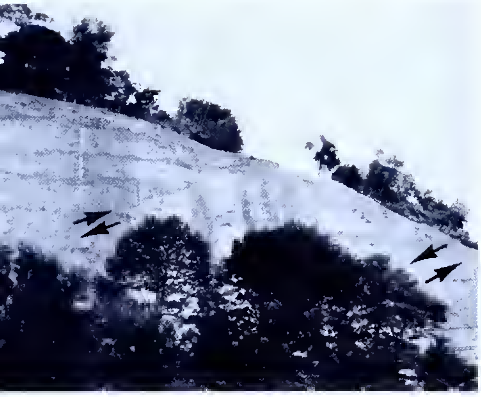


Fig. 1. View of road cut in Montebello sandstones showing thrust faults, with displacement of several feet, offsetting vertical strata. Direction of fault movement shown by arrows. Horizontal dark lines with no offset are blasting "lifts".

vertical which is 53 degrees measured from the horizontal. This angle was designed to be approximately parallel to a prominent fracture direction in the rock, thereby providing a more stable cut.

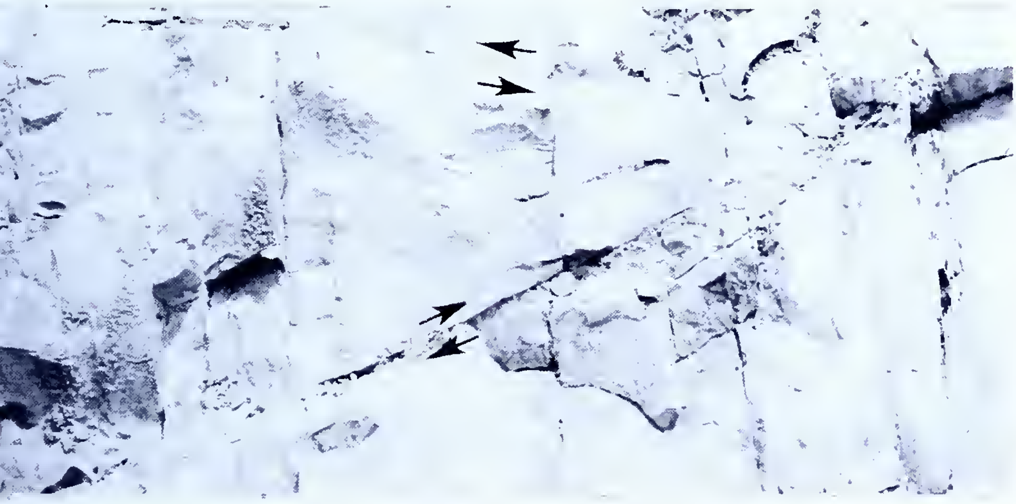


Fig. 2. Thrust faulting producing "wedges". Displacement of lower fault is about 3/4 inch (note coin for scale just below fault), displacement on upper fault is about 1/8 inch. Direction of fault movement shown by arrows.

Careful blasting technique is required to plane off the end of a mountain leaving a relatively smooth surface in rock units of varying hardness. The drilling and blasting method followed is called presplitting, i.e., a single crack is split along and parallel to the cut face by blasting, with the line fired a fraction of a second before the entire rock body to be removed is broken. The work is done in "lifts" of 20 to 30 feet from the top of the cut down (Figure 4). On this cut holes are drilled along the proposed face at a 53 degree angle, parallel to principal fractures, and spaced 30 inches apart.

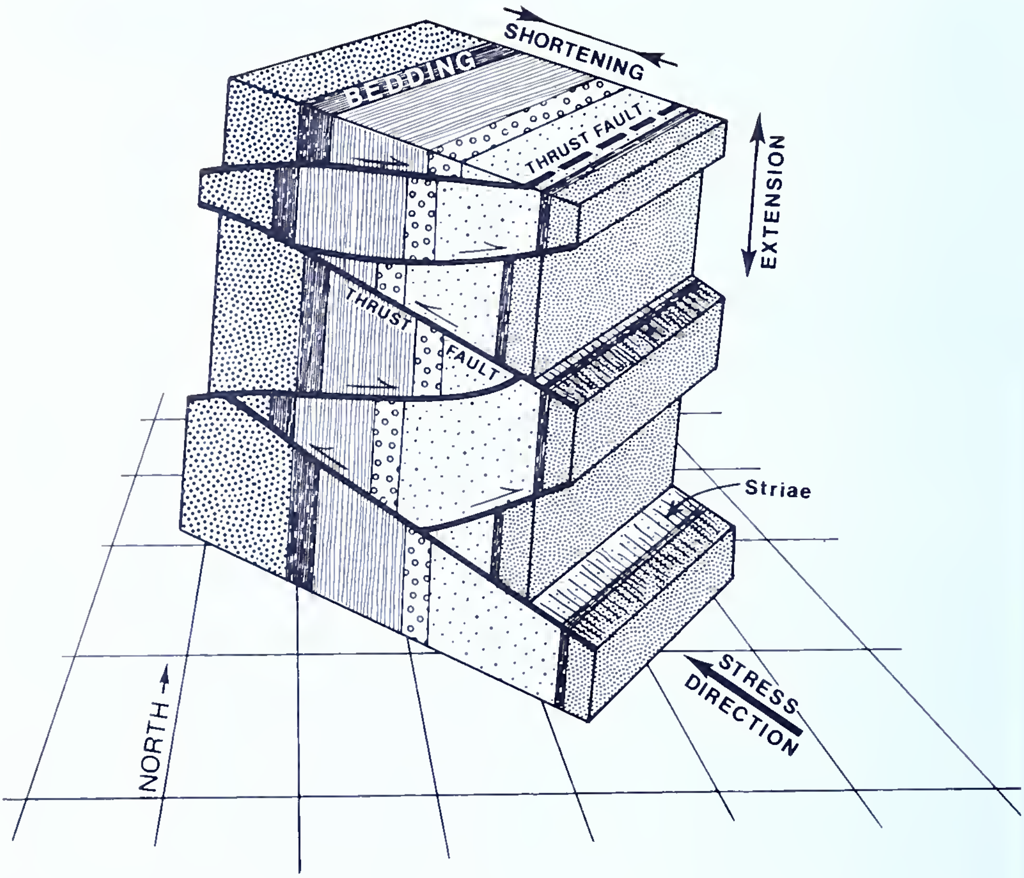


Fig. 3. Development of faulted "wedges" which extend strata vertically and shorten strata horizontally. Arrows show direction of fault movement. Modified from Cloos and Broedel (1943).

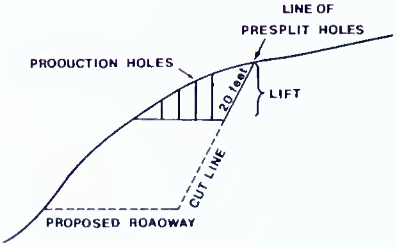


Fig. 4. Cross section sketch of a drilled lift for a road cut.

Next, vertical holes are drilled in the mass to be broken and removed. All the holes are loaded with explosive and as the shot is fired the explosive in the presplit line goes off first with the mass of rock against it; then, the rock to be removed is shattered. The millisecond delay allows the rock to split from hole to hole along the face, leaving a smooth surface.

Work on this cut was started in December 1975. Under the direction of District 8-0 of the Pennsylvania Department of Transportation, the Central Pennsylvania Quarrying and Stripping Company will excavate approximately 325,000 cubic yards of rock. The time of completion of the cut according to Joseph Schuech, Soils Engineer, will depend upon scheduling of other parts of the River Relief Route construction. The new highway is intended to be open to traffic by December 1, 1978.

During the course of excavation some unusual geologic features have been exposed. Spherical concretions of uncertain origin have been found in the hard Devonian sandstone which makes up most of the ridge. The concretions range in size from that of a cannon ball to several feet in diameter and are dense and heavy. Concretions are common sedimentary features developed during, or just after, deposition of the sediment which forms the sandstone. Sometimes the introduction of foreign matter into an accumulating sediment will cause a segregation of some of the constituents of the sediment. Concretions can form, therefore, in chemical response to an equilibrium disturbance. In other cases it appears, that there is a segregation of some of the minor mineral constituents of the sediment after

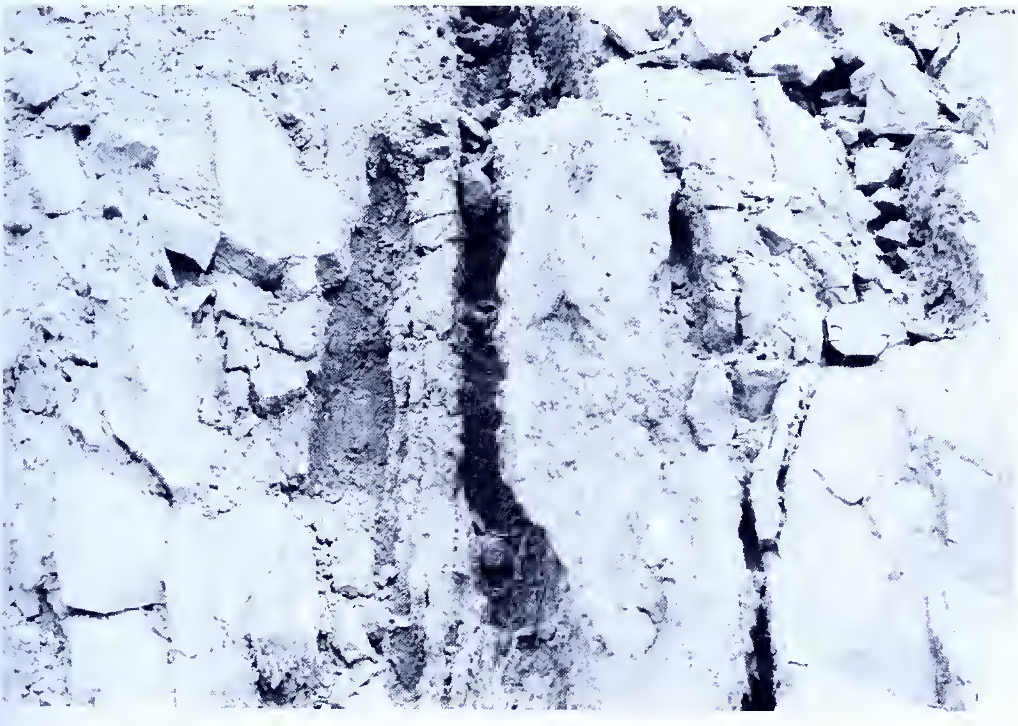


Fig. 5. Crumbly, unconsolidated sand bed between hard, indurated sandstone units. Note 3 inch Brunton compass on the right for scale.

deposition. However, analyses of concretions do not always give conclusive evidence of the origin of these secondary structures.

Another unusual geologic feature seen on the cut face are zones of crumbly sand in the midst of hard, well-indurated sandstone beds. (Figure 5) These softer zones form bed-parallel fissures recessed a few feet into the cut face and unconsolidated sand is frequently present. Apparently they are due to a general surficial leaching of beds rich in calcareous fossil shells. It is anticipated that these zones will not cause maintenance problems.

Several pronounced springs can be observed issuing from the new cut. These appear to be following along some of the more pronounced fracture zones, as well as the open zones where there has been leaching and removal of the crumbly sandstone.

Pennsylvania's Oil and Developments

A comprehensive summary of Pennsylvania's increased oil and gas activities is presented in the Bureau of Topographic and Geologic Survey's Progress Report 189, Oil and Gas Developments in Pennsylvania in 1975, by W. S. Lytle, R. G. Piotrowski, and Louis Heyman. Detailed data on drilling, discoveries, and production for the year is given in this annual report on a county-by-county basis. It is noteworthy that drilling for oil increased 3% and gas well drilling increased 36% over the prior year 1974. The most active gas well drilling was in Indiana County, while Warren, Venango, and McKean Counties saw the most active oil drilling. 1399 new wells were drilled in Pennsylvania during the year; of the 112 exploratory wells, 51% were successful; of the 1287 new development (field extension) wells 99% were successful. This is an excellent record of success. Total Pennsylvania oil production for 1975 was 3,199,000 barrels; gas production was 84,772 million cubic feet. All who are interested in Pennsylvania's oil and gas industry and the Commonwealth's ability to contribute to its oil and gas needs will find a wealth of information in this new report.

Progress Report 189 is available for $1.30 (plus tax for Pa. residents) from the State Book Store, P. O. Box 1365, Harrisburg, Pa. 17125.

EAST visits **WEST**

Mr. Sudip Kumar Bose, a geologist with the Directorate of Geology and Mining, Uttar Pradesh, India, received some in-service training experience with the Pennsylvania Geological Survey during July 1976. Mr. Bose, who is the recipient of a United Nations Fellowship, is visiting selected geological organizations in various parts of the United States to become acquainted with the methods and techniques being used in the exploration, evaluation and development of industrial or non-metallic minerals. While in Pennsylvania, his attention was directed especially to field work on geological projects concerning limestones, clays, and shales.

The training program in industrial minerals for Mr. Bose is a combination of academic and in-service training experience. Mr. Bose spent January through June taking selected courses at the School of Earth Sciences, Stanford University. The remaining portion of his program is being arranged through the Office of International Geology of the U. S. Geological Survey, and includes training with Federal and State agencies, and private industries. Upon completion of his training, Mr. Bose will return to his duties as a geologist with the Directorate of Geology and Mining, Uttar Pradesh, India. We hope that his Pennsylvania experience will help in the industrial development of India.

york mineral and gem show

The York Rock and Mineral Club will hold its Eighth Annual Mineral and Gem Show on Saturday, April 2 and Sunday, April 3, 1977 at the Manchester Township Fire Co. No. 1, in the Manchester Township Building, Emigsville, Pa. The firehouse is located in Emigsville, Pa. on Route 181, going north from York, Pennsylvania.

Show hours are Saturday, April 2, 10:00 a.m. to 9:00 p.m. and Sunday, April 3, 10:00 a.m. to 6:00 p.m.

EARTH SCIENCE TEACHERS' CORNER

plate tectonics in the classroom

In August the first planning conference of the National Association of Geology Teachers Education Project on Crustal Evolution was held at the University of Oklahoma which is the host institution for the project. The project will produce, as supplements to existing earth science curricula in grades 8 thru 12, a number of 1 to 3-day classroom instructional units. These will be based on current scientific research into the composition, history, and processes of the earth's crust and the applications of this knowledge to man's activities.

The intense oceanographic investigations during the past decade of the geological and geophysical properties of the ocean floors, and related studies on the continents, have led to a "revolution" in thought about the development of the earth and the formation of the most fundamental aspects of its frameworl. Thus, there exists today a "breaking story" in the earth sciences which is considered to rank in importance with such scientific advances as the development of the Darwinian Theory of Evolution, and the Bohr Atomic Model. A part of the rationale for this curriculum project is that teachers and students have a unique opportunity to share in the present unfolding of what is considered to be one of the most important interpretations of modern civilization about the nature of this planet, and its structure and development. The new crustal evolution concepts have touched off a period of accelerated activity that is rapidly expanding our knowledge of the origin of mountain ranges, thermal resources, earthquakes, volcanoes, zoogeographic distribution of plants and animals and metalliferous deposits. This is leading to increased ability to predict the location of potential mineral and energy resources, and the sites of future earthquakes, and has many other applications of importance to man's future. It is hoped that this project will be able to demonstrate a model for shortening the time lag for translation of ongoing research into useful classroom materials.

Development of instructional units will be carried on at centers located throughout the country, by teams consisting of college-based science educators, junior high school teachers, and active researchers.

geologic guide to interstate 81

A trip along Pennsylvania's Interstate 81, the Penn-Can Highway, can be turned into a geological field trip through use of a just-published booklet produced in cooperation by the Pennsylvania Geological Survey (Department of Environmental Resources) and the Bureau of Curriculum Services (Department of Education). The 35-page booklet, titled *Interstate 81 - Geologic Guide,* points out such problems encountered in building the road, outstanding geologic and scenic panoramas and numerous other points of interest along the route. A continuing map runs through the booklet to help pinpoint the items discussed.

A copy is available free of charge from Mr. William H. Bolles, Bureau of Curriculum Services, Department of Education, Harrisburg, Pennsylvania 17125.

Survey Draftsman Receives Award

Governor Shapp recently awarded Mr. Jack Kuchinski, Cartographic Draftsman of the Pennsylvania Geological Survey staff, a citation and a U. S. Savings Bond for a cost-saving procedure that Mr.

Kuchinski had developed. Mr. Kuchinski's money-saving technique involved the use of scribing tools to etch words, letters, and numbers directly onto mylar sheets being used to prepare detailed geologic maps. This eliminated several costly and time-consuming steps in the drafting and printing processes. Accompanying Mr. Kuchinski at the presentation was his supervisor, Christine E. Miles, Geologic Editor of the Bureau of Topographic and Geologic Survey.

Two Geologists Join Survey Staff

We are pleased to announce that Larry E. Taylor has joined the staff of the Pennsylvania Geological Survey at the Survey's Harrisburg office, and Stephen A. Krajewski at our Pittsburgh office.

Larry Taylor will work with the Environmental Geology Division and will primarily be responsible for projects in the area of ground water. Larry received his Bachelor of Science Degree in geology from the University of Toledo, Ohio in 1971 and his Master of Science Degree in geology from the same university in 1974. After graduation, he joined the staff of Moody and Associates, Inc., a groundwater consulting and well drilling firm located in Meadville, Pennsylvania. Larry had various assignments with Moody, ranging from participation in regional groundwater pollution to water supply development projects. He is a member of the Technical Division of the National Water Well Association and is interested in all aspects of groundwater resource utilization and management.

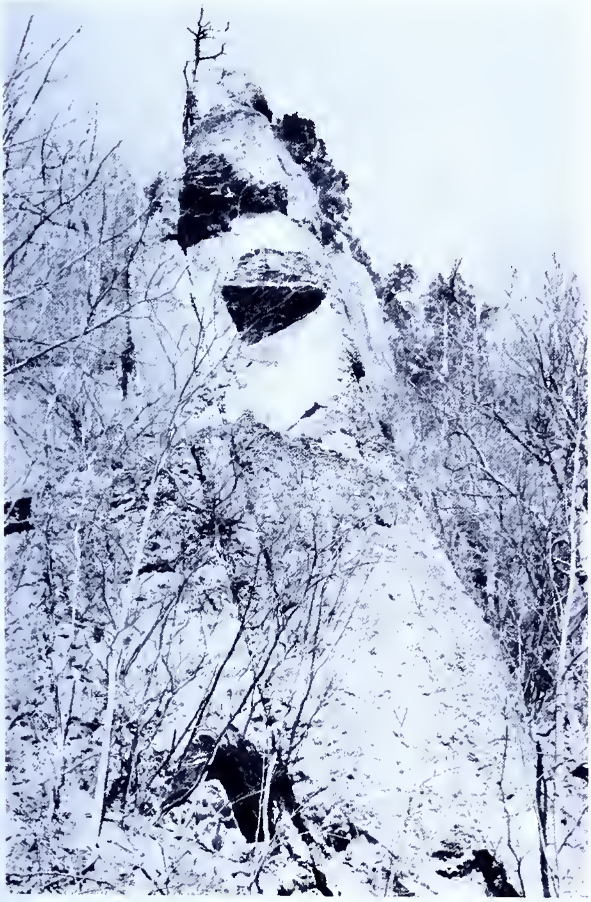
Steve Krajewski is assigned to the Oil and Gas Geology Division. His primary responsibility is to work on the Eastern Shale Gas Project being conducted in cooperation with the U. S. Energy Research and Development Administration. Steve received his B.Sc, degree in geography in 1968, his M.Sc. in geology in 1971, and he anticipates receiving his D.Ed. in earth science in June 1977, all degrees from the Pennsylvania State University. His geologic work experience includes geochemical field prospecting for platinum and nickel in the Stillwater Complex, Montana for Johns-Manville Corp.; paleo-environmental reconstruction in the Upper Devonian of Northeastern Pennsylvania for the mining of flagstones; conducting coal reserve exploration programs in West Virginia, Virginia and southwestern Pennsylvania for Jones and Laughlin Steel Corp.; sedimentologic analysis of Late Pleistocene barrier island sands in the Eastern Shore area of Virginia. In addition, he has taught geology, geography and oceanography at Washington and Jefferson College in Washington, Pennsylvania.

Prominent Limestone in Mifflin County

This photograph shows a rock promintory at the edge of the Juniata River near the Borough of Newton Hamilton. There are numerous similar exposures of this size in Pennsylvania but this one is unusual because it is made of limestone, a rock type that generally underlies valleys and does not often form prominent ridges.

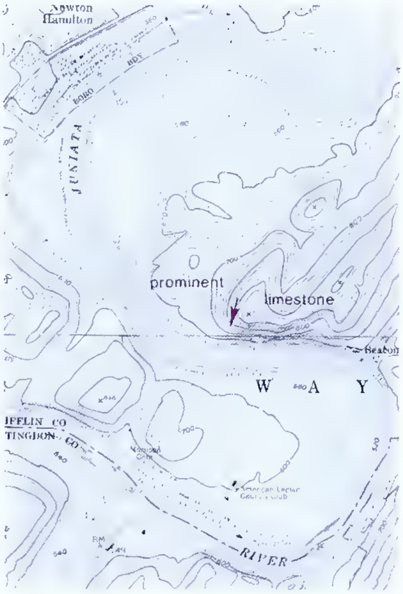
Limestone is composed mostly of calcite, a mineral which is readily soluble in acid. As the rainwater falls through the air, it picks up small amounts of carbon dioxide which combines to form weak carbonic acid. As the water percolates through the soil the acidity increases with the addition of organic acids. It is most common, therefore, in humid climates to see limestone weather faster than surrounding rock types resulting in the formation of valleys.

The anomolous exposure in the photograph is the result of structural forces which have deformed the rock and bent it into a large, tight fold. The result of that geologic deformation was to increase fracturing in the rocks on either side of the limestone causing them to weather away faster and leaving a limestone "wall" behind.



Keyser Limestone along the Juniata River near Newton Hamilton.

Photo by:
Peter Wilshusen, February 1976.



Ancient River a Possible Hazard to Coal Mining

by Mark Sholes

Modern rivers deposit sand, silt, and clay in characteristic patterns. The lithified equivalents of modern river (or fluvial) deposits can be recognized in ancient rocks. Ancient rivers locally cut deep channels, (in the same manner as modern rivers) which filled with sand and which are important today in western Pennsylvania because they cut down to or through mineable coal deposits. Where a sandstone cuts down through a coal, it may be necessary to drive a heading through the sandstone to mine the coal on the other side of the channel. In addition, certain areas associated with channels provide particularly weak mine roofs and present a serious hazard to underground mining (Kent, 1974). It is therefore important to locate ancient river deposits where they are associated with mineable coal deposits.

An ancient river deposit must have some distinctive characteristics in order to be recognized because not all sandstones in coal-bearing strata formed as fluvial channels. Sand may have been deposited as a beach, a barrier bar, a delta front bar or in tidal channels. The sand bodies produced in these different depositional environments have different shapes, geographic distributions and effects on mining operations in the vicinity of the sandstone body. Distinctive characteristics of fluvial-channel-fill sandstone bodies in western Pennsylvania are:

1. The lower boundary is erosional, a basal conglomerate is generally present, and other conglomerates are locally scattered through the sand body.
2. Grain size of the sediment decreases upward from the base.
3. Plant fragments are locally abundant in the sandstone and marine fossils are absent.
4. The general shape of the sandstone body is elongate in map-view and lens-shaped across the width in cross section.

In the Philipsburg-Houtzdale area of Centre and Clearfield counties there is an excellent example of an ancient river deposit which has a major affect on the local coal and its recovery. Glass (1971) traced the Kittanning sandstone across the Philipsburg 7½′ quadrangle by noting where the Clarion coal has been eroded away and replaced by the Kittanning sandstone, the areas where the sandstone is directly on the coal, and the westward and eastward increasing thickness of shale which overlies the Clarion coal where the sandstone rises off the coal (Fig. 1). Recent work in the southern half of the Houtzdale 15′ quadrangle using drill hole core descriptions allows the extension of this channel through southern Houtzdale and a more accurate determination of the three-dimensional shape of the sand body than was possible by Glass (Fig. 1). In addition to the sand-filled main channel, a variety of other sediments associated with the channel were deposited. These include levee deposits, overbank mud and locally peat. The Kittanning sandstone is representative of a medium-sized channel-fill deposit in western Pennsylvania. The effect of the sandstone on coal mining, however, depends not so much on the size of the sandstone as its relationship to the coal.

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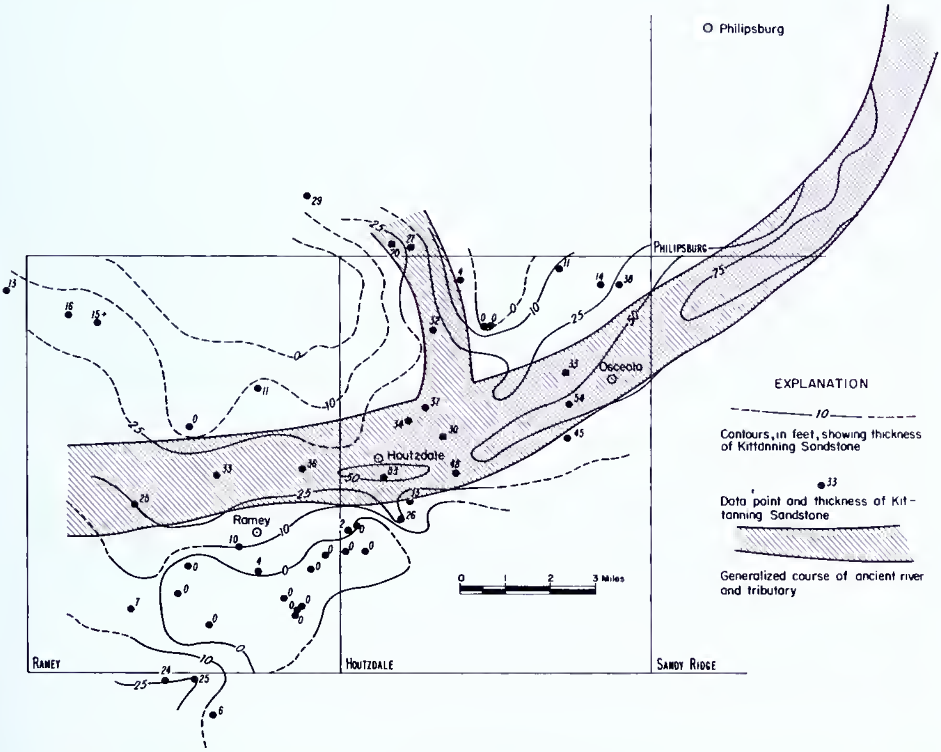

Philipsburg
Philipsburg
Osceola
Houtzdale
Ramey
Ramey
Houtzdale
Sandy Ridge
0 1 2 3 Miles
EXPLANATION
10
Contours, in feet, showing thickness of Kittanning Sandstone
33
Data point and thickness of Kittanning Sandstone
Generalized course of ancient river and tributary

Fig. 1. **Thickness of the Kittanning Sandstone in the Philipsburg — Ramey area.**

SURVEY ANNOUNCEMENTS

GREATER HARRISBURG AREA ENVIRONMENTAL ATLAS

One of the most complete compilations of geologic and environmental data ever offered for an entire metropolitan area has been published by the Bureau of Topographic and Geologic Survey as *Environmental Geology of the Greater Harrisburg Metropolitan Area.* Authored by former Staff Geologist William G. McGlade and Alan R. Geyer, the report presents by maps and text all of the detailed physical elements essential to effective engineering and transportation design, as well as agricultural and recreational development.

Covering an area of 16 by 20 miles, from Mechanicsburg to Hershey, the Harrisburg Area environmental atlas includes seven large, full-colored maps, each presenting data on a critical environmental factor: (1) layered relief map, (2) slope map, (3) drainage and flood-prone area map, (4) soil associations map, (5) geology and mineral resources map, (6) groundwater availability map, and (7) engineering geology map. All planning or zoning efforts, all transportation designers, and every community, commercial, or private entity involved with any type of construction of land use activity would greatly benefit by utilizing the information offered by these maps and their accompanying texts. By offering the citizens of the Greater Harrisburg Area information on physical conditions, natural resources, and natural hazards, they should be able to make decisions which will effect greater economy, greater safety, and wiser land use.

Environmental Geology Report #4, *Environmental Geology of the Greater Harrisburg Area,* is available for $17.65 (plus tax for Pa. residents) from the State Book Store, P. O. Box 1365, Harrisburg, Pa. 17125.

OIL AND GAS RELATIONSHIP TO LOCAL STRUCTURES

The relationship of oil and gas fields to local and regional geologic structures is presented in the Bureau of Topographic and Geologic Survey's Information Circular 80, **Greater Pittsburgh Region Revised Surface Structure and Its Relation to Oil and Gas Fields**, by the late Walter R. Wagner and by William S. Lytle. This illustrated, 20-page report is available for $0.80 (plus tax for Pa. residents) from the State Book Store, P. O. Box 1365, Harrisburg, Pa. 17125.

WILLIAMSPORT AREA GEOLOGIC MAPS AND REPORTS ON OPEN FILE

The Pennsylvania Geological Survey is placing on open file the recently completed geologic maps and accompanying reports of four 7½-minute quadrangles between Williamsport and Jersey Shore in Lycoming County. The quadrangles are Linden, Williamsport, Salladasburg, and Cogan Station. The maps show both the bedrock geology and the distribution of the surficial deposits throughout the area. The reports, which are being readied for printing, describe each of the geologic units, discuss the various types of geologic structures, provide evaluations of the environmental and engineering properties of each of the geologic units, and describe the significant economic deposits and occurrences within the area. These reports, authored by staff geologists Rodger T. Faill, Richard B. Wells, and William D. Sevon, may be examined at the Harrisburg offices of the Pennsylvania Geological Survey, Room 914, Executive House, 101 S. Second Street, Harrisburg, Pennsylvania 17101.

MAP TO AID PROPER COAL DEVELOPMENT

The depths to one of the major coal deposits underlying Allegheny, Westmoreland, Beaver, Butler, and Armstrong Counties are given in detail on the Bureau of Topographic and Geologic Survey's new Map #49, **Greater Pittsburgh Region Thickness of Rocks Over the Freeport Coal.** Knowing the thickness of the rocks overlying this coal formation is important (1) in planning the future mining techniques for this valuable coal deposit, as well as (2) in planning and designing appropriate surface development in the areas where the coal will be (or already has been) mined beneath the surface. This map will serve as an important aid to all who are concerned with both energy resource development as well as effective land use conservation.

Map #49 is available for $2.10 (plus tax for Pa. residents, from the State Book Store, P. O. Box 1365, Harrisburg, Pa. 17125.

CAVES OF PENNSYLVANIA

In keeping with its long tradition of providing up-to-date maps and reports on Pennsylvania's caves, the Bureau of Topographic and Geologic Survey has issued two new publications on the subject.

General Geology Report 67, **Caves of Western Pennsylvania** provided details of 79 caves in the 12 counties of Allegheny, Armstrong, Butler, Clarion, Fayette, Indiana, Jefferson, Lawrence, Mercer, Somerset, Venango, and Westmoreland. There are 45 figures and plates to supplement the 97 pages of text material which were compiled by members of the Mid-Appalachian Region of the National Speleological Society and edited by Dr. William B. White of the Pennsylvania State University.

Caves of Western Pennsylvania is available for $3.00 (plus 6% tax for Pennsylvania residents) from the State Book Store, P. O. Box 1365, Harrisburg, Pa. 17125.

Geology and Biology of Pennsylvania Caves is the title of the Bureau of Topographic and Geologic Survey's newly issued General Geology Report 66. Edited by Dr. William B. White of the Pennsylvania State University, this 103-page report has three parts: The part on The Geology of Caves is by Professor White; the part on The Cave Fauna of Pennsylvania is by Professor John Holsinger of Old Dominion University; the part on Appalachian Bone Caves is by Dr. John E. Guilday of the Carnegie Museum.

Bulletin G 66 provides the reader with a comprehensive understanding of the origin of Pennsylvania's caves, their forms and features, and their animal populations or past and present. **Geology and Biology of Pennsylvania Caves** is available for $2.00 (plus 6% tax for Pa. residents) from the State Book Store, P. O. Box 1365, Harrisburg, Pa. 17125.

Jefferson County Topo Map to Pinpoint Local Sites

Modifying the Jefferson County topographic map cooperatively issued by the Pennsylvania and U. S. Geological Surveys, the Jefferson County Planning Commission has prepared a new map with a detailed grid overprint that can be used by police, fire and local officials as well as the public to accurately locate problem sites and other points of local concern.

These new county maps are intended to provide an accurate topographic map at reasonable scale for use by local citizens and officials. We are pleased to see that the county is making this unexpected use of these maps. Copies of the modified Jefferson County topographic maps may be obtained at $2.00 each from the Jefferson County Planning Commission, 82 Barnett Street, Brookville, Pennsylvania, 15825.

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100 Forbes Ave., Pittsburgh, Pa. 15222
William S. Lytle, *Division Chief*

Lajos Balogh, *Draftsman*
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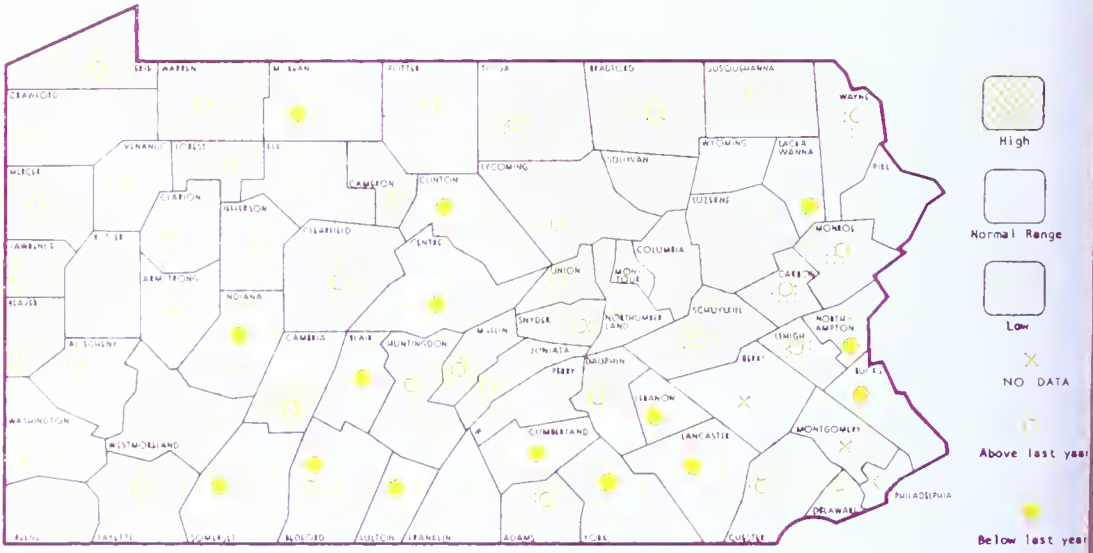

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ON THE COVER: One of Venango County's older oil wells, a tribute to Pennsylvania's past and present contribution of energy raw materials.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

Articles may be reprinted from this magazine if credit is given to the Topographic and Geologic Survey.

APRIL 1977

FROM THE DESK OF THE STATE GEOLOGIST . . .

NOT YET, NOT YET

In the early 1950's, while finishing up my thesis field work near one of my favorite towns, Crested Butte, Colorado, I was struck by the fact that outhouses were the most conspicuous plumbing facility of the town. I approached a veteran citizen of the community and asked why it was that with most of the homes equipped with running water, only two could boast the existence of flush toilets. After a moments careful thought, he replied, "Those things just haven't been perfected yet."

I was reminded of that little episode when I read recently that a judge has declared void the OCS (Outer Continental Shelf) oil and gas development leases on the Atlantic Coast. After at least ten years of studies by government, academic, and consulting researchers on possible physical, biological, economic, and social environmental impacts on both the offshore and the onshore environments that might be affected by OCS drilling, and after scores of environmental reports which total tens of feet of library shelf space, the judge has ruled that environmental impact statements for the OCS program haven't been perfected yet.

True, even today we find that flush toilets haven't been perfected yet, and neither have automobiles or airplanes. So it is probably also correct that the OCS environmental impact statements haven't yet been perfected. But how long can we wait to attain perfection?

This is not to make light of the importance of comprehensive, meaningful environmental impact evaluations, particularly with reference to activities affecting our life-giving oceans, and our coastlines. Through service as Pennsylvania's representative on the advisory committee to the President's Council of Environmental Quality, I developed a profound respect for the complexity and significance of environmental impacts related to prospective OCS drilling. But my experience also impressed me with the fact that neither a final analysis nor a final course of environmental protection can be achieved. We must do what we can for the environment now, but also recognize that unanticipated developments will occur and we must be prepared to respond to them promptly as they arise.

Speaking of unanticipated developments. I am also reminded of a recent exchange of communications. We announced in an earlier edition of this journal that the Pennsylvania Survey was undertaking a comprehensive geologic mapping project which, barring unforeseen difficulties, would take two years to complete. A serious, well-intentioned reader responded with a letter inquiring "Please list the unforeseen difficulties which might cause a delay in the project." It appears the latest ruling on the OCS is based on similar logic.

Arthur A. Socolow

New Gas Discovey in Lycoming County Sparks A Flurry of Activity

by Richard Wells

Natural gas exploration in north-central Pennsylvania received a shot in the arm when the discovery well in the Salladasburg Field in Mifflin Township was completed last November. Initial production in the John Ware III No. 1 Hess was 1,000 mcf per day from 29 feet of Ridgeley sandstone at a depth of 6,271 feet. The well is located a mile northeast of Salladasburg on Tombs Run anticline, on a prospect described in Pennsylvania Geology last year (Wells, 1976). A confirmation well, the Ware No. 1 Charles Emig, slated to test the Ridgeley sandstone is drilling a half-mile southwest of the discovery.

Geologic mapping on Cogan Station and Salladasburg Quadrangles (Faill and Wells, in press) indicates a closure of at least 500 feet on the surface, with the highest point on the structure lying northeast of the Hess well, towards Quiggleville.

Another Devonian test, the Pennsylvania Energy Resources Number 1 Woodley, is currently drilling in Mill Creek Township northeast of Montoursville. The operators have announced another five well locations in this same area, one of them on the same farm. These are stratigraphic tests in the 2000 - 3600 foot range, being drilled to evaluate the potential of sandstone beds in the Upper Devonian "Chemung" or Lock Haven Formation. Several beds of very-fine to fine-grained, slightly calcareous sandstone were reported in this interval in the Delta Number-1 Ging well in Cascade Township, north of Wallis Run

Bodines Quadrangle (Fettke, 1956). These five new locations are the No. 2 Woodley (Huntersville E), No. 1 Lauchle in Muncy Township (Huntersville H), No. 1 Schaeffer (Huntersville I) and No. 1 McCloskey (Picture Rocks G), both in Wolf Township, and the No. 1 Miller in Upper Fairfield Township (Montoursville North F). The Miller location is on the crest of the untested Warrensville anticline.

Meanwhile, Pennsylvania Energy Resources, a subsidiary of Pennsylvania Gas and Water Co. of Wilkes-Barre, have purchased an abandoned dry hole some two miles east of the Woodley farm, and moved in a rig to clean out the hole, run logs and tests. This well was originally the Storey No. 1 Berkheart, drilled in 1954 to a depth of 6,854 feet and abandoned in the Middle Devonian somewhere above the Onondaga Formation. This well reportedly will be deepened to about 7,000 feet to the Ridgeley sandstone, after gas shows in upper formations are tested.

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Publication on Drilling of World's First Oil Well

The Department of the Interior has published its second Bicentennial historical vignette — Success At Oil Creek — which describes the drama and events that led to the drilling of the world's first oil well in 1859 by Colonel Edwin L. Drake near Titusville, Pennsylvania.

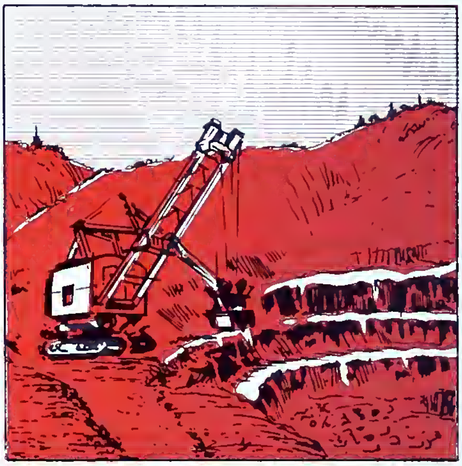
The recognized birth of the petroleum industry in the United States occurred August 27, 1859, along Oil Creek in western Pennsylvania. There, the famed Colonel Drake, a former railroad conductor and jack-of-all-trades, proved that oil could be found in quantity by drilling into the earth.

At 69½ feet, the hole he bored filled with oil to signal monumental changes in the development of the world and the history of man.

The 24-page illustrated Bicentennial Vignette, *Success At Oil Creek,* is for sale for 65 cents by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The stock number is 024-000-00823-1.

The Role of Geology in Coal Mining*

by C. Richard Dunrud
U. S. Geological Survey, Denver, Colorado



Geology plays an important role in both underground and surface coal mining. In underground mining, the lithology, structure, and ground-water conditions of rocks above and below the coal affect the behavior of these rocks in response to mining in three important ways: First, structure and lithology control the rate and direction of erosion, which, in turn, govern the thickness, depth, and configuration of the overburden and consequently control those stress conditions that are related to topography. Faults, joints, and ground water tend to weaken rocks in the overburden and to increase the rate and amount of subsidence above mine workings. Second, any active organic stresses can alter, increase, and otherwise modify the stresses produced by topography. Third, the lithology and the primary and secondary structures in the rocks above and below the coal — such as bedding, cross-bedding, organic structures, channel sandstones, dikes, joints, and faults — tend to influence stability of the mine roof and floor. Knowledge of the ways in which these structures affect the stability of the roof is very important, because statistics show that roof falls are the primary hazard to coal miners.

Short- and long-term stability of highwalls and spoil piles in surface-mining operations also are controlled by the structure and lithology of the bedrock, by local surface-water and ground-water conditions, as well as by climate. The depth limit and benching requirements for stripping overburden, for example, are governed to a large extent by the short-term strength of the bedrock, which is controlled by the structure and lithology and by the distribution of surface and ground water. The final grading specifications for the last cut in a surface mine depend upon the long-term slope stability of the bedrock, which is in turn governed by the strength of weathered rock. Chemical weathering and leaching of spoil piles, as well as the stability of the slopes and of the settlement characteristics of the regraded materials, also are controlled by the lithology and structure of the initial bedrock or surficial material, as well as by the climatic conditions in the mining area. These factors, therefore, are important to well-planned and efficient surface restoration.

*Abstract of talk given at the U. S. Geological Survey Symposium on Coal Geology and the Future, Reston, Va., September 27, 1976.

mineral production UP

The recently issued U. S. Bureau of Mines summary of the mineral industry of Pennsylvania in 1975 highlights a continued growth in the value of raw mineral resources produced, reaching a figure of just under $3 billion, up 22% over the prior year. Coal again was the largest single commodity in value, accounting for approximately 75% of the total value of minerals produced in the Commonwealth. Following coal, in decreasing order of dollar value, were cement, stone, lime, natural gas, sand and gravel, petroleum, zinc, clays, and peat.

Pennsylvania's stone values led the nation; lime was second in the nation; zinc product value was seventh in the nation. Northampton and Lawrence Counties led in cement production, Montgomery and Bucks Counties headed the stone production, Centre County was the leading county in lime production, and Bucks and Armstrong Counties headed a long list of sand and gravel producers.

At this time of energy concern, it is noteworthy that Pennsylvania's oil production for the year was 3.3 million barrels valued at $39.6 million, and the natural gas production was 84.7 billion cubic feet valued at $57.1 million.

New Guide to Mining and Mineral Operations

For those who have an interest in locating and visiting outstanding past and present mining and mineral operations, the U. S. Bureau of Mines has issued an impressive, beautifully illustrated 72 page booklet entitled, **Mining and Mineral Operations in the New England and Mid-Atlantic States**. This is one of a series of six such reports which collectively cover the entire United States.

The publication on the New England and Mid-Atlantic states locates and described 119 individual localities in the states of Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

Mining and Mineral Operations in the New England and Mid-Atlantic States is sold by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The price is $2.30 and the stock number is 024-004-01889-5.

geologists present geologic hazards seminar

Dr. Jesse L. Craft, Environmental Geologist, Pennsylvania Geological Survey; Dr. Kent Bushnell, Slippery Rock State College; and Mr. Larry Davis, Washington Jefferson College presented a one and one-half hour seminar on geologic hazards and how they influence community planning at the Annual Meeting of the Pennsylvania Planning Association. The meeting was held in Seven Springs on October 7, 8, 9, 1976, and over 400 individuals involved in community planning attended the conference. Topics covered in the seminar were landslides, deep mine subsidence and tributary stream flooding. Emphasis was given in the seminar on use of existing geologic information for input into the early planning of projects with the community.

new water data system

The Commonwealth of Pennsylvania, Department of Environmental Resources has become a participating member of the National Water Data Exchange (NAWDEX). NAWDEX is comprised of water-oriented organizations working together to provide convenient access to water data. The NAWDEX mission is to identify sources of water data, to index data holdings of water-oriented organizations, and to provide the linkage between those who acquire and those who use water data.

The U. S. Geological Survey (USGS), through its NAWDEX Program Office, will provide the central management of NAWDEX, and will serve as a coordinating facility for all NAWDEX facilities.

VOLUME 7/3 PENNSYLVANIA GEOLOGY NEEDED

Due to an unfortunate circumstance, some libraries did not receive Volume 7/3 of Pennsylvania Geology (June 1976). In order to fill out their sets to provide complete volumes, we are issuing an appeal to anyone who wishes to return their Volume 7/3 issue. These will be distributed to libraries and other public institutions who need them for completing bound volumes. Please return to Pennsylvania Geological Survey, P. O. Box 2357, Harrisburg, PA 17120.

SURVEY ANNOUNCEMENTS

MERCER COUNTY REPORT ISSUED

Geology and Ground Water Resources of Northern Mercer County, Pennsylvania, has been published by the Bureau of Topographic and Geologic Survey as Water Resources Report 33. Authored by George R. Schiner and Grant E. Kimmel of the U. S. Geological Survey, the 136-page text with 8 large, full-colored geologic maps presents a comprehensive description of the geologic conditions and groundwater resources upon which planning, development, and conservation must be based.

The geologic maps and text descriptions of the rock formations and glacial deposits provide the basic data necessary for all forms of land use, including transportation, home construction, industrial development, agriculture, and recreational facilities. The detailed data on available subsurface water quantity and quality, based on studies of some 2,000 wells in the area, is especially important to this northwest Pennsylvania region of growing population and development.

Water Resources Report 33, **Geology of Ground Water Resources of Northern Mercer County** is available for $17.50 (plus 6% tax for Pennsylvania residents) from the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, PA 17125.

MINERAL CLUBS ANNOUNCE MEETINGS

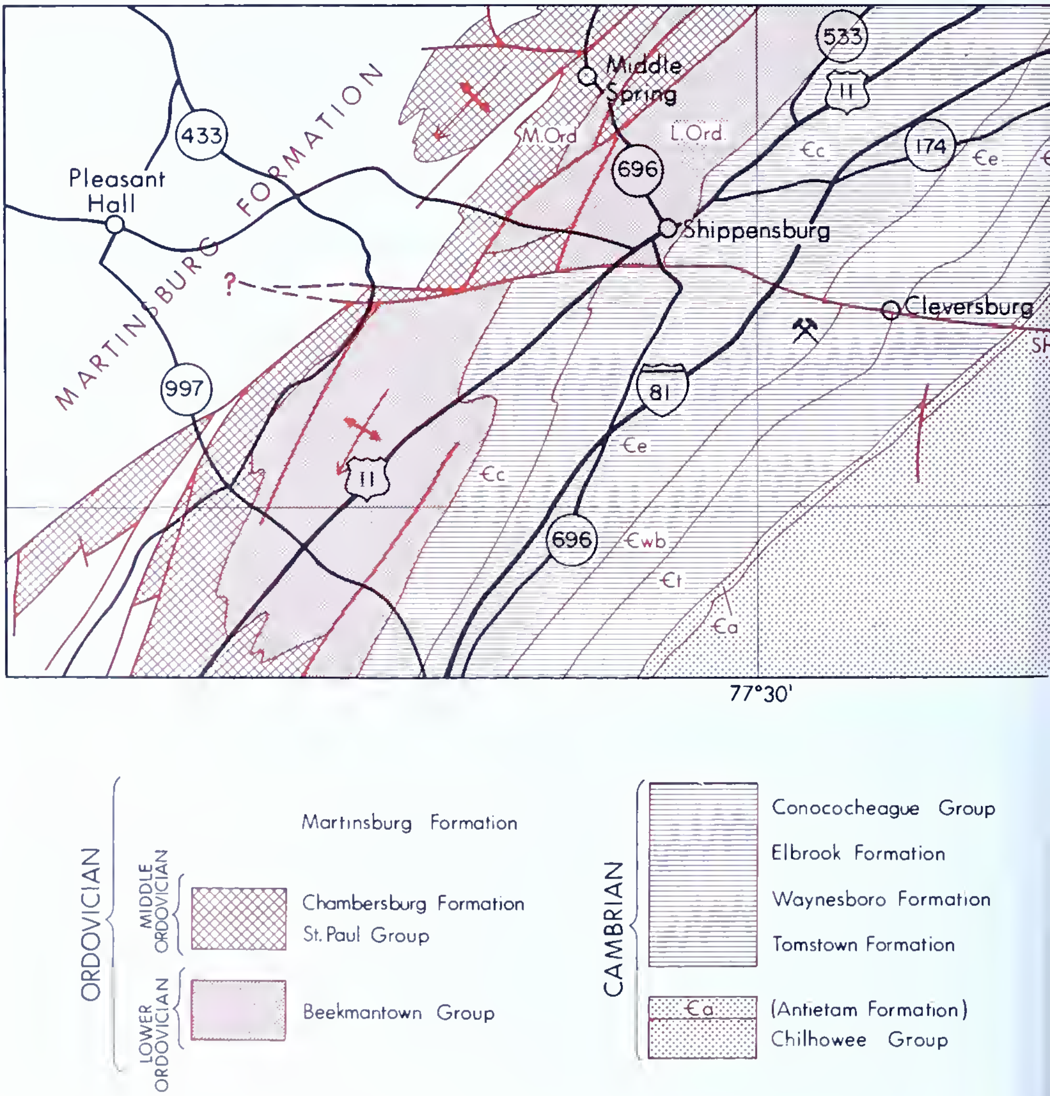
The Mineralogical Society of Pennsylvania will hold its 13th Biennial Earth Science and Mineral Show, entitled "Earth Treasures," at the Guernsey Barn, five (5) miles east of Lancaster, Pa., on Route 30, at the intersection of Route 896, on May 28-29, 1977.

The York Rock & Mineral Club, Inc. will hold its fifth Annual "Rock Swap" on Saturday, June 4th and Sunday, June 5th, 1977 at Rohlers Picnic Grounds on Rohlers Church Road. These picnic grounds are located three (3) miles east of Mt. Royal off Pennsylvania Route 74. Mt. Royal is approximately 2 miles north of Dover, Pennsylvania on Route 74.

MAJOR CROSS STRUCTURES IN PENNSYLVANIA (PART I)

by Samuel Root and Donald Hoskins

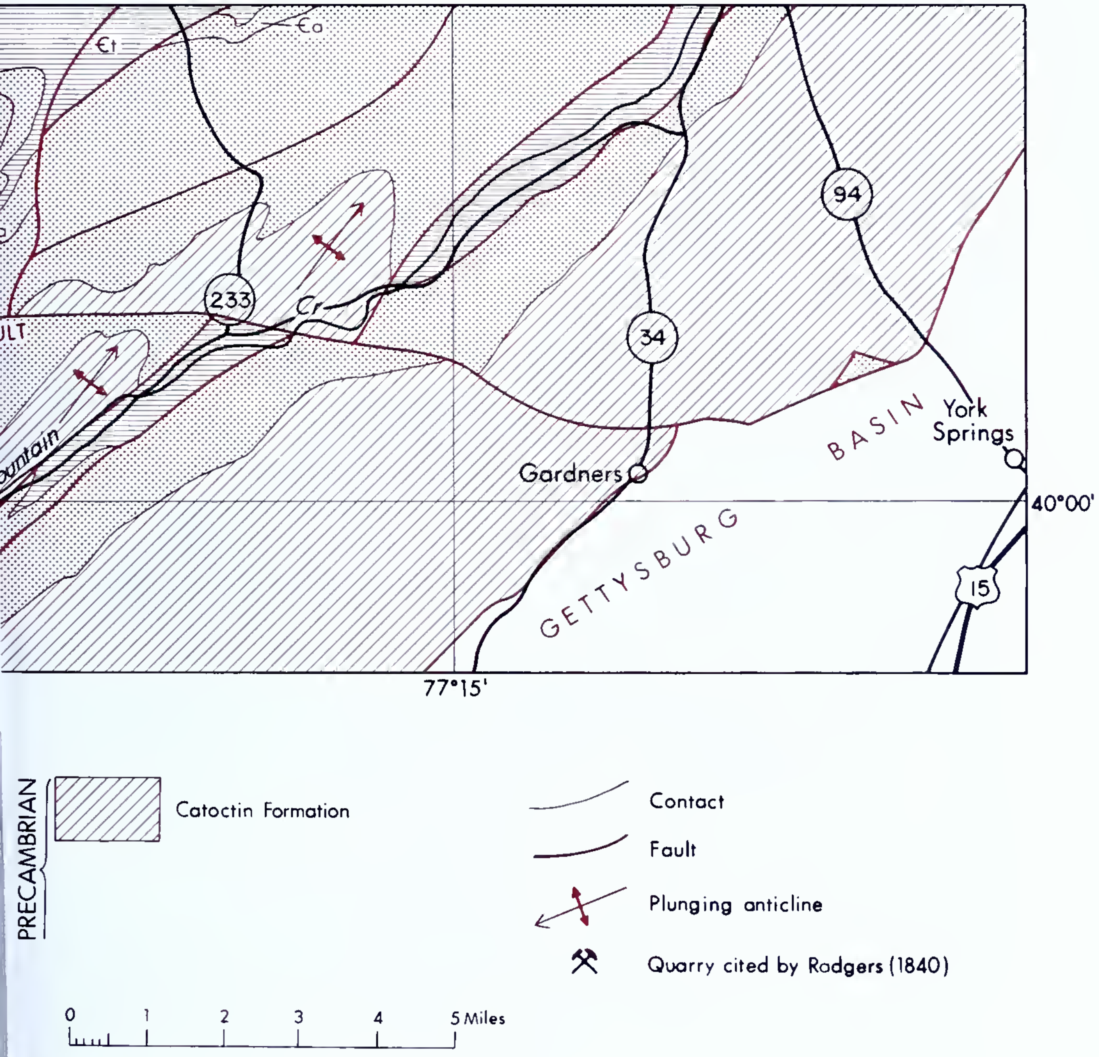
Detailed geologic mapping in the Cumberland Valley in conjunction with Survey hydrologic investigations, and reconnaissance mapping in South Mountain, related to compilation of a new State Geologic Map, confirm an unusual fault a few miles north and approximately parallel to N 40° latitude. Similar mapping by D. M. Hoskins in the Valley and Ridge Province to the west confirms two additional new and unusual faults along the same east-west trend.



The Valley and Ridge faults will be discussed in Part II of this article.

Most of the previously mapped faults in the complex Cumberland Valley-South Mountain Anticlinorium are steep thrusts, usually moderately dipping to the southeast, and parallel to the northeast-southwest trending structural grain. This newly recognized fault, named the Shippensburg Fault, differs significantly from most of the other faults in the region.

The Shippensburg Fault (Figure 1) trends east-west at a considerable angle to the regional structural grain. It has a relatively straight trace, even in the high-relief terrain of South Mountain, which indicates a subvertical attitude. It has a mapped length of 23 miles (37 km), covered on the east by Triassic rocks of the Gettysburg Basin, and on the west it extends into terrain of the Martinsburg Forma-



tion where its identity is lost.

In the area shown on the map, structures are not merely offset across the fault as with a simple tear fault. Rather, in the Great Valley carbonate terrain, semi-independent shortening on either side of the fault is inferred because folds and faults cannot be matched across the fault, although structures are related in a general way. However, in South Mountain simple offset occurred as structures in the Cambrian Chilhowee Group quartzites and Precambrian Catoctin metavolcanics can be matched across the fault. From relations in the metavolcanics, the block north of the fault is interpreted to have been uplifted between 2900-4200 feet (880-1280 m). Based on offset of vertical Antietam quartzite ridges, there is also component of left-lateral slip which appears to be less than the amount of vertical displacement.

The Shippensburg Fault is located in a regionally significant structural position. North of the fault structures of the South Mountain Anticlinorium, all plunge northeast; south of the fault all structures plunge southwest. Therefore, the fault is on the structural culmination of the South Mountain Anticlinorium.

Principal deformation of the rocks in the region is considered to be at the end of the Paleozoic (Alleghanian Deformation). Because semi-independent shortening occurs across part of the Shippensburg Fault, it may have been active during the shortening process and may be part of the Alleghanian Deformation. The eastern part of this fault may have been active after the deformation that formed the Gettysburg Basin because the border fault that marks the northwest margin of the basin is offset where it transects the Shippensburg Fault. The Shippensburg Fault may reflect a deep-seated zone of weakness rather than dermal faulting related to shortening above a detachment horizon. Affinities with the similar Carbaugh-Marsh Creek Fault near Chambersburg (Root, 1970 and 1971) are indicated.

Of particular interest is the possibility of mineralization associated with the Shippensburg Fault. Ore from a limonite iron mine close to the fault near Cleversburg, which was operated in the early 1800s, formed abundant, peculiar encrustations in the Mary Ann furnace stack where it was smelted. These crusts analyzed at 92.5% PbO (Rodgers, 1840). Geochemical sampling from the B-soil horizon near this quarry by R. Smith II (in preparation) indicates values of Zn 6 times greater than regional background and Pb 25 times greater than regional background. Chemical analyses of limonite from this area contain .28% Zn and .05% Pb. Both this fault and the Carbaugh-Marsh Creek Faults may be prospective areas for Pb-Zn exploration.

More significant than establishing the presence of this fault in the Cumberland Valley and South Mountain is the recognition by Hoskins of related faults farther west (to be discussed in more detail in Part II of this paper). Along the east-west trend of the Shippensburg Fault through the Fannettsburg, Burnt Cabins, Hustontown, and Breezewood quadrangles, other similar faults crossing the structural grain have been mapped in compilation for the new geologic map of Pennsylvania. Other faults on this east-west trend extend, intermittently, westward to near the Allegheny Front. Across the Front on the Allegheny Plateau an extension of the faults merits consideration based on anomalous patterns on the aeromagnetic map and its interpretation of this region (Popenoe and others, 1964 and Beck and Mattick, 1964). A slightly northwest-trending anomaly passes near Pittsburgh, continuing to Ohio. Also, a zone of subsurface structural discontinuity (Wagner and Lytle, 1976) coincides with the aeromagnetic anomaly.

The authors believe that this zone of faulting represents a major fault, or zone of weakness, in the continental crust along which movement of various types occurred in the Paleozoic and Mesozoic. As this structure transects virtually two-thirds of Pennsylvania, the name Transylvania Fault is proposed for this feature.

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The Geological Society of Pennsylvania 1832-1836

by Anne Millbrooke

Part 2: Promoting a State Survey

(Part 1, Published in Dec. 1976, v. 7/6)

To establish a state geological survey, the Geological Society lobbied for the passage of a state law. Although a bill was considered at each legislative session, the geological survey did not win legislative approval until 1836. In the spring of 1833, however, a committee of the House of Representatives recommended "an appropriation by the Legislature to make a Geological Survey of the State under the direction of the Geological Society of Pennsylvania."[1] Politics and economics, as well as the character of the Geological Society, decided the establishment of the Pennsylvania geological survey.

The committee of the House of Representatives passed favorably in the spring of 1833 on a memorial submitted by Peter A. Browne and modified by the Geological Society. Through a committee consisting of Chief Justice John B. Gibson, Dr. Richard Harlan, and engraver Henry S. Tanner, the Geological Society proposed, with little geologic justification,

> to establish accurately three meridian or transit lines, extending entirely across the state, to be denominated the eastern, the middle, and the western meridians of the state, measured with the utmost care and precision, and permanently marked at intervals of a mile, or oftener, on suitable posts or stones, set for that purpose.
>
> Measurements of the elevation above mean tide carefully marked, and the latitude of each line precisely determined by a series of astronomical observations. Also, another line traversing the state longitudinally, which would intersect nearly every variety of rocks which exists in our state, and afford important connexions with the primitive meridians.[2]

The legislative committee included this proposal in a bill, which, if passed, would have provided not more than $15,000, and not more than $5,000 in any one year, for a geological survey of the state. Although Pennsylvania would not be the first state to sponsor such a survey, the committee argued that the proposed survey would "unquestionably redound to the credit of the state, and richly repay any expenditure in its attainment."[3]

The political and economic picture confronting the legislature in 1833 strongly influenced the decision not to fund the geological survey, which came with canals and railroads under the general heading of internal improvements. The legislature had passed in 1826 its first internal improvement program; it authorized the construction of canals and the borrowing of funds to pay the expenses. Later the program was expanded to include railroads, principally because Pennsylvania was in competition for trade with New York, Albany, and Baltimore. In order to compete successfully the state needed transportation systems; therefore, canals and railroads were of higher priority than a geological survey. As the internal improvement program grew, so did the state debt. Even before 1833 the legislature became aware of the state's precarious financial situation and began to cut back public works or internal improvements. The state geological survey, thus, was not funded in 1833, despite the favorable committee report, because the legislature was consciously limiting internal improvement expenditures. By 1836 when the geological survey of Pennsylvania was established, the political and economic situation had changed.

After the rejection of a state survey by the 1833 legislature, the Geological Society continued its promotional efforts but changed its tactics. Up till then the Geological Society had been arguing from an economic ideology that said that state agriculture and manufactures, and therefore the whole state, would economically benefit from a survey. The argument was similar to that used in support of canals and railroads. But economic priorities being what they were, the Geological Society turned to an ideology of science that claimed a purity of motives. A new constitution adopted in January of 1834 reflected the change in ideology. It specified seven activities for the promotion and diffusion of geologic knowledge: (1) "the collecting, digesting and publishing . . . [of] new, interesting and useful facts and discoveries in Geology"; (2) "the gradual accumulation of the most approved books, maps, specimens, and all such documents and materials as shall best elucidate the science"; (3) "preparing brief instruction for members of this society, or others, who design to visit distant parts of the state"; (4) "affording pecuniary or other assistance to such travellers or surveyors as may require it"; (5) "corresponding and communicating with similar societies abroad"; (6) "inviting communications, either speculative or practical from members and others"; and (7) "causing the formation of auxillary societies in the several counties of the state."[4] Advocacy of a state geological survey, which was the dominant theme of the earlier constitution, was implicit, not explicit, in the new constitution.

The appeal of science was also expressed by the publication of the Geological Society's *Transactions*. The volume, which included a memorial in support of state geological survey, was published in two parts, the first in 1834 and the second in 1835. The Geological Society had changed its image. In 1835 it had more than two hundred members. It had moved from the hospitality of the Franklin Institute to its own quarters in the new Exchange Building. Lectures on geology and mineralogy were given weekly, and the cabinet and library had grown. Still the Geological Society was not a scientific society in the professional sense; its membership consisted primarily of amateur scientists. Less than five percent of the membership, for example, contributed to the *Transactions,* and less than two percent (that is, four members) wrote more than half the articles. Moreover, the *Transactions* received a guarded review in the *American Journal of Science*, which trusted that "it is only an earnest of more to come."[5]

The Geological Society of Pennsylvania, a Philadelphia based organization, had three types of membership – honorary, corresponding, and residential. Approximately half of the over two hundred members were residents; honorary members could be counted on one hand. The list of corresponding members contained the names of many notable foreign scientists: Alexandre Brongniart, French geologist and chemist; Adolph Brongniart, French botanist; William Buckland, British geologist; Alexander von Humboldt, German naturalist; R. I. Murchison, British geologist; and Adam Sedgwich, British geologist. The list also included various people scattered throughout the United States, like Edwin James of Albany and Gerard Troost of Nashville. The corresponding members, however, were not active in the Geological Society. Only one, Gerard Troost, published in its *Transactions*. Residential members controlled the Geological Society. Unlike among the corresponding members, practicing scientists were rare among the residential members. They were principally physicians, businessmen, and lawyers. The officers in 1834, as in 1832, reflected the amateur nature of the membership. The only significant change was the substitution of a geologist for a judge in the presidency. Andres del Rio, the new president, was a professor of mineralogy in the School of Mines in Mexico. While temporarily residing in Philadelphia, Del Rio lent his name to the Geological Society, giving the appearance of science.

On the 19th of March 1836 the Pennsylvania legislature passed an act providing for a geological survey of the state. It authorized the governor to appoint a state geologist, who, in turn, would appoint an assistant in mineralogy and an assistant in chemistry. The state geologist and his assistants were to make

> a geological and mineralogical survey of the state, with a view to determine the order, succession, arrangement, relative position, and the dip or inclination and also the comparative magnitude of the several strata or geological formations within the state, and to discover and examine all beds and deposits of ores, coals, clays, marls, and such other mineral substances as may be deemed useful or valuable, together with such other duties as may be necessary to make a full and complete geological and mineralogical survey of the state.[6]

The act provided for an annual appropriation of $6,400; $2,000 was for the state geologist's salary, $1,200 for each assistant, $1,000 for expenses incurred by the chemist, and $1,000 for incidental expenses. The act established the First Geological Survey of Pennsylvania, but it made no mention of the Geological Society of Pennsylvania.

The passage of the act establishing a state geological survey reflected the economic and political situation of Pennsylvania in 1836.[7] The state's early internal improvement program, which began under Governor John Shulze, was financed almost entirely through loans, many from the United States Bank. As the program expanded, the debt grew, and though the program was cut back under Governor George Wolf, the debt remained. President Andrew Jackson, meanwhile, stopped depositing federal funds in the United States Bank. The president of the United States Bank, Nicholas Biddle — an officer of the Geological Society — began to call in loans in case Jackson should decide to withdraw the federal funds already deposited in the United States Bank. The result was that fewer monies were available. By 1835 the monetary situation was unstable. The political situation, to complicate matters, was also unstable. The Democratic Party in Pennsylvania split between Governor Wolf and Henry A. Muhlenberg. As one newspaper described the situation: "The *'wolves'* and *'mules'* of Pennsylvania, as two of the parties to the election of governor are *politely* called, are telling tales of one another that both parties ought to be ashamed of — and will be, 'after the election'."[8] In the 1835 fall election a third party candidate, Joseph Ritner, was elected governor. He was, in addition to being anti-Mason and anti-Van Buren, was pro-Bank and pro-internal improvement. The United States Bank was then chartered by the state of Pennsylvania, prolonging its life beyond the 1836 federal expiration date. Ritner, with aid of legislators Thaddeus Stevens and Charles B. Trego, guided the act for a state geological survey through the state legislature.

The same arguments that the Geological Society had early advanced in its promotion of a state survey, that is the economic and educational arguments, convinced the state to finance a survey. The 1836 act specified that the state geologist and his assistants were "to discover and examine all beds and deposits . . . and such other mineral substances as may be deemed *useful or valuable*" [emphasis added]. It also provided for state and county cabinets to display the geology of the state. The act did require the geologist and his assistants to be scientific, but they were also to be practical. The state legislature, like the Geological Society, advanced science for economical reasons.

The Geological Society accomplished its purpose. Despite rhetoric, like the reference in the *Transactions* to "the future success and permanency of this institution,"[9] the success of the Geological Society necessitated its expiration. In 1836 the Geological Society was the political pressure (or, if you prefer, civic minded) group that it had been in 1832, but now without a cause it dissolved. Chief Justice Gibson never intended to participate in the survey. He and the majority of the members of the Geological Society were not scientists and would reap the benefits of the state geological survey regardless of who conducted it. Those few members with survey aspirations chose to leave the Geological Society in 1836 rather than work through it. G. W. Featherstonhaugh, for example, became U.S. Geologist, and Peter A. Browne became professor of mineralogy and geology at LaFayette College in Easton, Pennsylvania. Having accomplished its political and sole purpose, the Geological Society of Pennsylvania died a natural death.

NOTES

[1] Pennsylvania General Assembly, House of Representatives, "Report of a Committee of the House of Representatives, recommending an appropriation by the legislature to make a geological survey of the state, under the direction of the Geological Society of Pennsylvania. Mr. Say, Chairman — Read March 23d, 1833," *Hazard's Register of Pennsylvania,* 11 (13 April 1833), p. 225.

[2] Pennsylvania General Assembly, "Report . . . ," p. 225.

[3] Pennsylvania General Assembly, "Report . . . ," p. 226.

[4] Geological Society of Pennsylvania, *The Constitution and Bye-Laws, to which is added a list of the officers and members of the society* (Philadelphia, 1834, pp. 8-9.

[5] "Notice of the Transactions of the Geological Society of Pennsylvania — August, 1834, Part I," *American Journal of Science and Arts,* 27 (1835), p. 347.

[6] "Act of 29th March 1836," *Parke & Johnson's Digest,* v. 2 (Philadelphia: James Key, Jun. & Brother, 1837), p. 594.

[7] For general discussion of the economic and political situation, see Louis Hartz, *Economic Policy and Democratic Thought: Pennsylvania, 1776—1860* (Cambridge: Harvard University, 1948); and Philip S. Klein and Ari Hoogenboom, *A History of Pennsylvania* (New York: McGraw-Hill Book Company, 1973).

[8] *Niles' Weekly Register,* 49 (26 September 1835), p. 50.

[9] Geological Society of Pennsylvania, *Transactions,* I (1835), p. 414.

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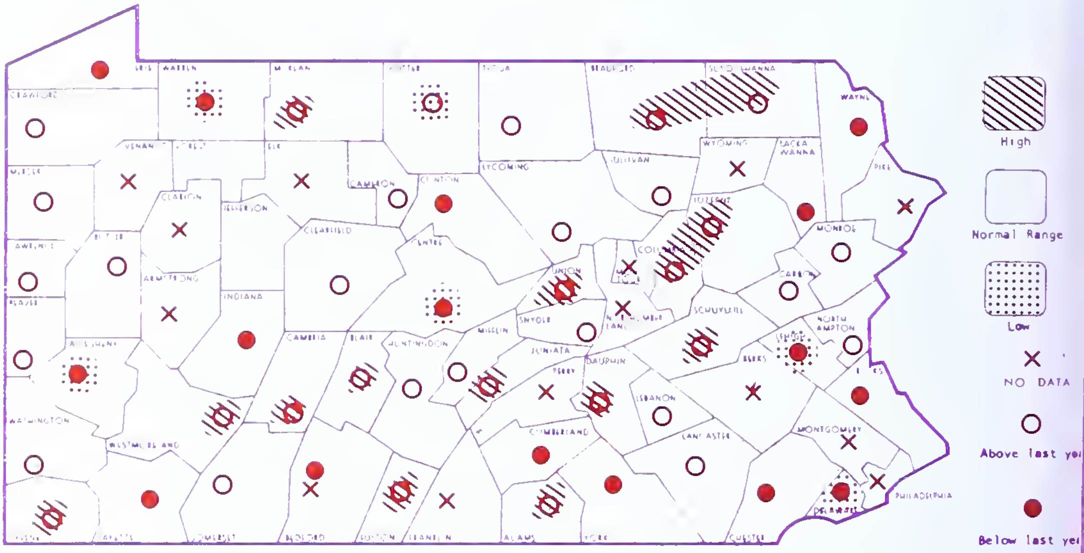

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ON THE COVER: Multiple benefits are provided by sands exposed in a borrow pit near Oakland in Susquehanna County. Originally deposited by glacial meltwater during late Wisconsinan deglaciation, these deposits now provide homes for cliff swallows and sand for man.

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Articles may be reprinted from this magazine if credit is given to the Topographic and Geologic Survey.

JUNE 1977

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

LABELS ARE CREATED BY MAN

This publication tries to keep the readers informed on geologic developments of general interest. In certain instances these turn out to be issues of some controversy. As scientists and public servants, our responsibility at the State Geologic Survey is to share our data and experiences with all who are interested, regardless of their respective viewpoints. Such is the case with the current interest in the recognized and potential uranium mineral occurrences in Pennsylvania.

In recent months a number of exploration geologists have visited our offices pursuant to our recognition and identification over the years of nearly 50 locations of uranium-bearing mineral concentrations in Pennsylvania. Those are mineral occurrences with which Pennsylvania has been naturally endowed and the present interest in them is due to the increased demand for such resources. The exploration geologists tell us that Pennsylvania has one of the Nation's most favorable undeveloped geological settings for the occurrence and discovery of uranium-bearing mineral concentrations.

Yet even as there is a commercial interest in exploring for uranium concentrations in Pennsylvania, there have also come forth voices of concern and opposition, in several cases blocking further exploration. Some of these state that uranium resources are basically dangerous and morally evil, and that their development should be either discouraged or banned in Pennsylvania.

One cannot escape the reality, however, that the uranium concentrations do exist in the Commonwealth, and the more we can know about them, the better off we would be, whether from an industrial standpoint or an environmental standpoint.

There is, furthermore, a basic question as to whether a resource, or any item, is in itself evil. The same type of engine which drives us to work or to recreation, also propels tanks on missions of destruction. Planes that fly us speedily to far distant destinations also are capable of bombing missions. Dynamite has been used in deadly weapons, but more so for constructing roads, building foundations, farmlands, and reservoirs.

And so it is with uranium resources. While many properly shudder at the horrors that they associate with nuclear warfare, all too many persons do not recognize the beneficial uses of radioactive materials which are related to uranium resources. Thousands have benefited

(Continued on Page 7)

Pennsylvania Land Use Maps Completed

Detailed land use maps of the entire Commonwealth of Pennsylvania have been completed by the United States Geological Survey under a cooperative agreement with the Pennsylvania Department of Environmental Resources.

Representatives of the Federal agency presented the completed land use maps to DER Secretary Maurice K. Goddard on Friday in ceremonies in the Secretary's office.

Dr. Goddard noted that Pennsylvania is one of the first states in the Nation to have a completed land use survey using the sophisticated new techniques devised by the U.S. Geological Survey.

The LUDA (Land Use Data Analysis) program was introduced by the U.S.G.S. in 1974. Utilizing the latest photo imagery available from high altitude planes, the land use and land cover classification system can recognize and delineate as many as 37 separate land use categories, some for areas as small as 10 acres. The scale of the final maps which have been prepared is 1/250,000 or approximately one inch on the map equalling four miles on the ground.

Recognizing the potential benefits to the Commonwealth and its various planning and economic programs, DER's Bureau of Topographic and Geologic Survey, with the cooperation of the Bureaus of Environmental Planning and Systems Management, worked to arrange a cooperative agreement with the U.S.G.S. in 1975 to prepare land use and land cover maps for all of Pennsylvania.

For this project, Pennsylvania was divided into 14 subdivisions, each of which corresponded to a standard 1:250,000 scale topographic base map. For each of the 14 base maps, six overlays were compiled including the land use and land cover map which identifies 30 different categories of land use. Other overlays show county boundaries, river basin boundaries, State land areas, Federal lands and county census subdivision.

One of the most important aspects of this new mapping program is that the data have been digitized and placed on magnetic tapes so they can be stored in a computer, reproduced, evaluated and analyzed in various ways. The data also can be updated readily as newer information becomes available in future years. Changes in land use will be identifiable, both in type and quantity. With the data digitized, it will be possible to enter other map data into the system and print overlays of other mappable characteristics. Thus, local, state or regional users of land use data will be able to update and add new categories of data or devise systems for subdividing the existing categories.

In announcing completion of the land use maps, Secretary Goddard noted they can be a valuable tool for anyone involved in comprehensive land use planning. These maps and data should benefit State and local government agencies, transportation planners, industry, energy planners, agriculture, conservation groups and recreation agencies. The digitized data on computer tapes from which the map was plotted will be finished in approximately six months and will be housed and made available through the Bureau of Systems Management, Second Floor, Fulton National Building, Third and Locust Streets, Harrisburg.

The initial 98 maps and overlays which were delivered by the U.S.G.S. (seven for each of the 14 subdivisions) will be housed and maintained at the Bureau of Topographic and Geologic Survey, 914 Executive House, Second and Chestnut Streets, Harrisburg. The maps will be available for review and inspection at the Bureau offices and may be copied at the users expense.

Copies of the Pennsylvania land use and land cover maps and associated overlays are also available for review and inspection at the U.S. Geological Survey's National Cartographic Information Center (NCIC) East, Eastern Mapping Center, Room 2B200, National Center, 12201 Sunrise Valley Drive, Reston, Va., Telephone 703-860-6336; the map names and USGS open-file report identification numbers are Clarksburg 76-035, Cumberland 76-036, Canton 76-041, Wilmington 76-636, Cleveland 77-105, Warren 77-106, Williamsport 77-107, Scranton 77-108, Harrisburg 77-109, Pittsburgh 77-110, Neward 77-111, Erie 77-112, Buffalo 77-113 and Baltimore 77-114. Copies also may be purchased at NCIC East. A paper diazo copy of each map or overlay is $2, a film diazo copy is $5.60 and a stable-base film positive copy is $22.

* * *

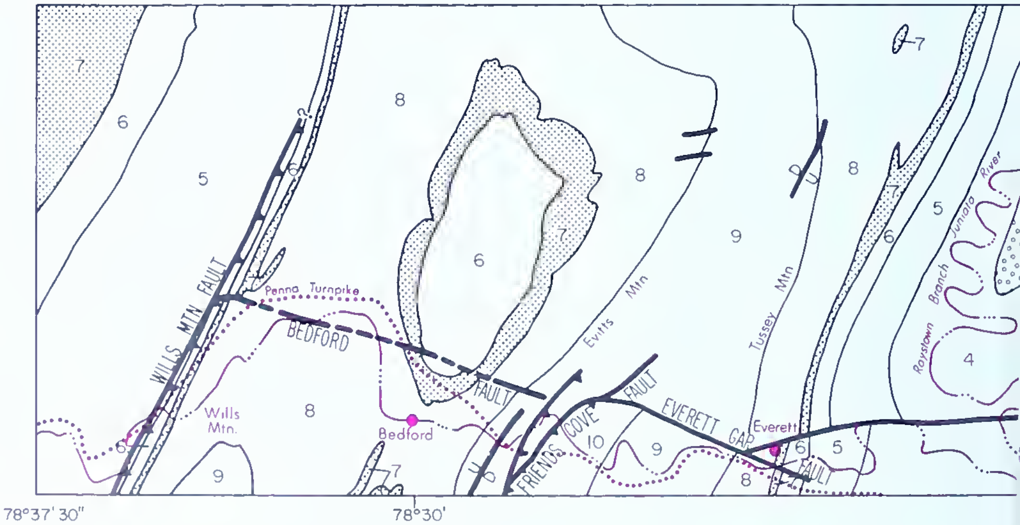
MAJOR CROSS STRUCTURES IN PENNSYLVANIA (PART II)

With Notes on a Possible New Location for Natural Gas Exploration

by D. M. Hoskins and S. I. Root

This is the second of a two-part article (for Part I, see Pennsylvania Geology, vol. 8/2, p. 8-11) describing unusual cross structures discovered while preparing the new Geologic Map of Pennsylvania.

West of the termination of the Shippensburg Fault and along its trend no additional surface offsets are known until two short faults offset the Tuscarora Formation on Tuscarora Mountain. Several small, short faults also offset the same formation just north of N 40° latitude on the next two Tuscarora ridges to the west (Cove Mountain and Scrub Ridge). These latter short faults are probably related to faulting associated with the northern end of the McConnelsburg thrust fault which here is composed of several traces as it feathers to extinction.



Geologic Map of Sideling Hill, Bre

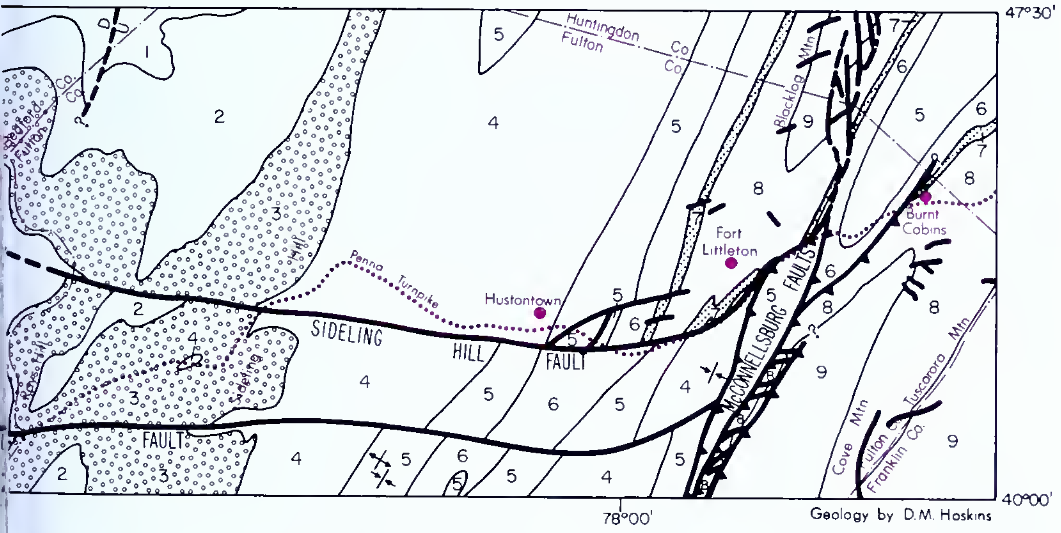
1	Pennsylvanian
2	Upper Mississippian
3	Lower Mississippian
4	Upper Devonian (A)

Area suggested as potentially suitable for natural gas exploration

The northerly of the two major faults west of the McConnellsburg Fault is here called Sideling Hill Fault. It begins paralleling the Pennsylvania Turnpike and McConnellsburg Fault at the Fort Littleton exit of the Pennsylvania Turnpike where it juxtaposes Middle Devonian rocks. Within one kilometer, its trace is nearly east-west where it crosses the nose of Shade-Black Log Mountain anticline and places late Silurian rocks in contact with Middle Devonian rocks. South of Hustontown, the basal contact of the Catskill Formation is displaced one kilometer to the west. Displacement of contacts and structures where the fault crosses the Broad Top synclinorium indicate vertical movement.

As with most faults, exposure of rock in the fault zone is nearly non-existent. A nearly unique outcrop along the Sideling Hill Fault existed during the construction of the now unused Sideling Hill Tunnel of the Pennsylvania Turnpike. The Sideling Hill Tunnel was constructed in the fault zone because the associated topography on Sideling Hill allowed for the shortest tunnel in this area. Cleaves and Stephenson (1949, Plate 24) show the complexity of folding and faulting encountered in what should have been a region of nearly uniform, low angle, northwest dip.

The trace of the fault west of the Turnpike tunnel is shown by the prominent abrupt termination of the Mauch Chunk Formation



d Faults, South-Central Pennsylvania

7	Lower Devonian
8	Silurian
9	Ordovician
10	Cambrian

in the Ray's Hill-Sideling Hill syncline. The portion of the fault west of the tunnel was independently determined by W. S. Kowalik (personal communication).

Two miles south of the Sideling Hill Fault, a more extensive fault, herein named the Breezewood Fault, parallels the same east-west trend. The eastern portion of the Breezewood Fault shows displacement westward of the base of the Catskill, similar to the Sideling Hill Fault. North of Breezewood, the movement is apparently vertical. Here rocks below the Catskill are elevated and the nose of the plunging anticline defined by the basal contact of the Catskill reappears. At Everett the formation contacts are displaced westward south of the fault, implying again lateral movement.

The Breezewood Fault joins with the fault mapped for a short distance by Knowles (1966) and in his report, referred to as the Everett Gap Fault. The Everett Gap Fault, more properly, is restricted to the west-northwest trending fault from Everett to where it joins with the Friends Cove thrust fault. Knowles (op.cit.) also noted a fault offsetting Evitts Mountain on strike but not continuous with the Everett Gap Fault. He did not map it westward but new mapping shows that it continues for another six miles, joining with another short segment of a fault previously mapped by students at the 1930's Penn State Field Camp.* Evidences for the fault between the two previously mapped short segments are (1) offset of the late Silurian and early Devonian rocks in the notch where the Pennsylvania Turnpike crosses a ridge north of Bedford, and (2) the anomalous straight stream segment of the west branch of the Juniata River where it cuts into and through the very resistant Tuscarora Formation south of Wolfsburg. The Bedford Fault continues westward and joins with the northern portion of the Wills Mountain thrust fault which bounds the west side of the Wills Mountain Anticlinorium. No observable offsets occur in surface rocks west of this junction.

The junction of the Breezewood and Everett Gap faults marks a change of the structures from a nearly east-west to a west-northwest trend. This trend continues to the Ohio-Pennsylvania line, as mentioned in Part I of this report.

A Possible Locality for Natural Gas Exploration

North of Breezewood, rocks below the base of the Catskill are upthrown in an anticlinal structure which is cut off by the Breezewood Fault. These rocks are not present south of the fault because they had disappeared by northward plunge approximately five miles south of the Breezewood Fault near Mattie. South of Mattie, along the same anticlinal structure, is the Purcell gas field described by Cate (1963). Since the anticlinal structure which contained natural gas in the Purcell field is repeated north of the Breezewood Fault in the anticlinal structures which occur near Graceville, it is within the realm of possibility that this structure and its terminating fault may form a trap for natural gas and might be considered as a locale for testing its potential for the production of natural gas.

*Maps on file at the Pennsylvania Geological Survey.

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(FROM THE DESK Continued)

from diagnostic nuclear medicine and nuclear scanning devices which can detect body malfunctions while effective treatment is still possible; other thousands have received life-saving radiation treatments to combat cancerous growths. Radioactive materials dependent on uranium resources are also being widely used in industry to test the structural soundness of metallic objects and metal welds. Most recently, this technique was used to spot and repair the faulty welds of the Alaska pipeline. Radioactive tracers are being used to track down and curtail leakages of pollutant liquids and gases, and other radioactive sources are used to sterilize surgical equipment.

Our naturally endowed resources are in themselves neither good, nor evil. Those attributes depend upon the uses that man imposes upon them. And thus in considering Pennsylvania's uranium resources, consideration should be given to the benefits they might contribute.

Arthur A. Socolow

Pennsylvania Geological Survey's Best Sellers For 1976

The number one and two best sellers continue, as in the past two years, to be G-40, *Fossil Collecting in Pennsylvania,* and G-33, *Mineral Collecting in Pennsylvania.* The most popular map continues to be Map No. 1, *The Geologic Map of Pennsylvania.*

"Cavers" found G-65, *Caves of Southeastern Pennsylvania,* an attractive item and it was our third most popular seller. Fourth and fifth on the popularity list were our two recent reports on bituminous coal, Report M-68, *Bituminous Coal Resources in Southwest Pennsylvania,* and M-69, *Analyses and Measured Sections of Pennsylvania Bituminous Coals;* this reflects the interest in Pennsylvania's major energy resources.

The environment was on the minds of purchasers of our publications because our Environmental Geology Reports No. 1 and No. 2, *Engineering Characteristics of the Rocks of Pennsylvania* and *Environmental Geology for Land Use Planning* again were our 6th and 7th most popular, after dropping from the top ten in 1975.

Field trips to local areas interested our readers as our *Guide to the Geology of the Pittsburgh Area,* Bulletin G-59 was our eighth most popular seller.

Ninth and tenth place were shared equally by two reports on economic mineral resources; one, our Bulletin PR 188 which was *Oil and Gas Developments in 1974* and one of our oldest reports, Mineral Resource Report M-6, Part 1, *Bituminous Coal Fields of Pennsylvania.*

Maps 42, 43, 44, and 45 were the most popular after Map 1. These four maps are all of the Pittsburgh region and are titled, respectively, the Geologic Map, Structure Contour Map, Oil and Gas Fields Map, and Mined Out Area Map of the Greater Pittsburgh Region.

as youngsters see us

(from an article by Harold Dunn, *Science Digest* – June, 1976)

"Knowledge about rocks and minerals has advanced to the point where it is no longer understandable."

"One of the main byproducts of rocks is geologists."

"We have had rocks on earth forever and maybe even longer."

Central Pennsylvania Sand Dunes

by Carol Myrna Chase

Along the east bank of the West Branch of the Susquehanna River opposite Lewisburg is a sand dune field created during the Wisconsin age, the latest of several periods of glaciation that covered parts of Pennsylvania. Although the Wisconsinan glacier halted several miles to the north of the West Branch (Figure 1), large amounts of its sedimentary debris were flushed into the river and deposited on floodplains downstream.

As the glaciers retreated and the supply of sediment dwindled, the river began to cut into the material it had previously deposited, leaving terraces on the sides. As the river eroded downward, the water table was lowered, causing the terrace surface to dry out, thus providing a supply of loose material for the wind to move about.

Along the east bank of the river in Northumberland County opposite Lewisburg, the floodplain is extremely broad, and the terraces are well developed. The prevailing westerly winds swept across the lower terraces, and picked up the silt and sand sized particles, depositing them on the upper terraces to the east.

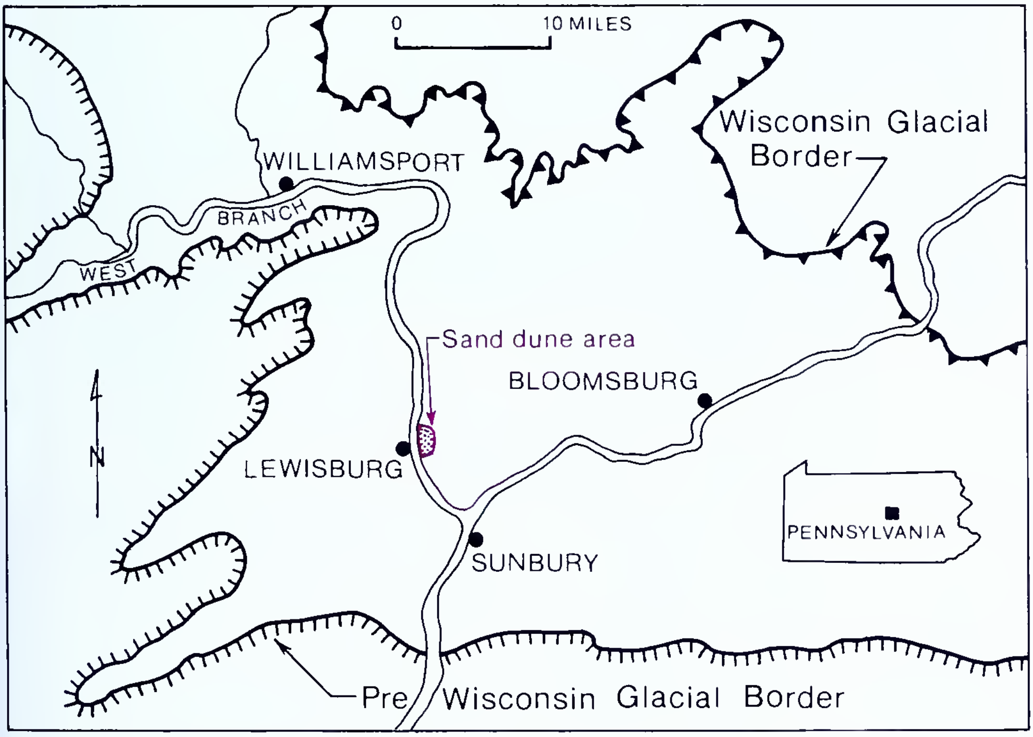

Fig. 1 Index map of the sand dune area showing approximate extent of area glaciers.

The sand was first blown into transverse dunes (Figure 2), long, parallel sand ridges which trend perpendicular to the direction of the wind. In cross-section they are asymetric with their steep faces to the

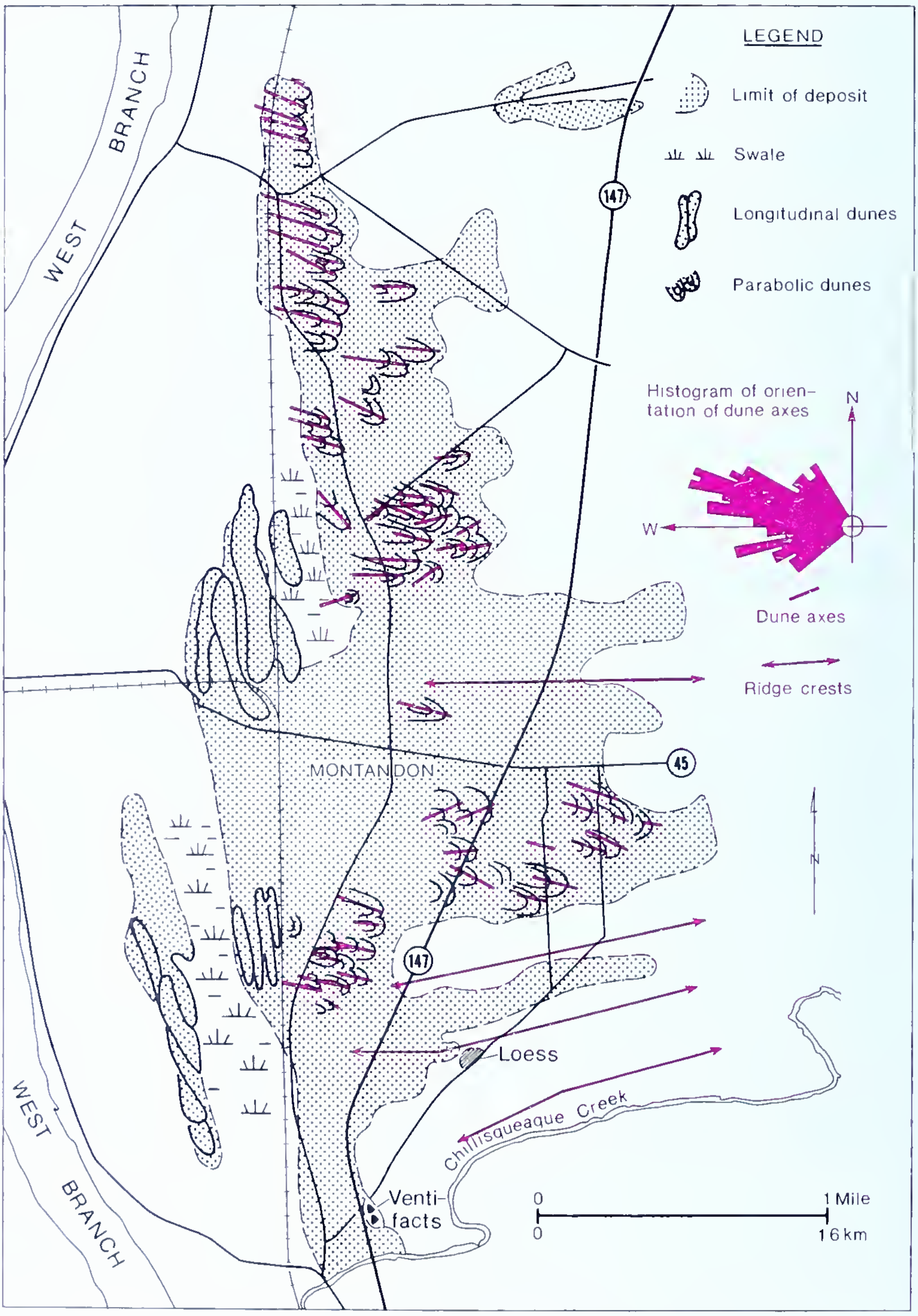

Fig. 2 Map of the surficial deposits of the sand dune area.

leeward. The sand grains were rolled and bounced by the wind up the gentle windward slope and then down the steep slope in the calm air to the leeward of the dune.

To the east of the transverse dunes is a swale where the high water table creates a poorly drained marsh, the water being empounded by the transverse dunes to the west and the upper terraces to the east.

East of the swale, the sand has been blown out into parabolic dunes in a dunefield which extends approximately a mile and a half east of the river. Parabolic dunes are U-shaped dunes with the tails oriented upwind and the convex, steep slope, oriented downwind. If the tails are anchored by vegetation, the dune may be stretched out downwind into long, hairpin-like forms (Figure 3).

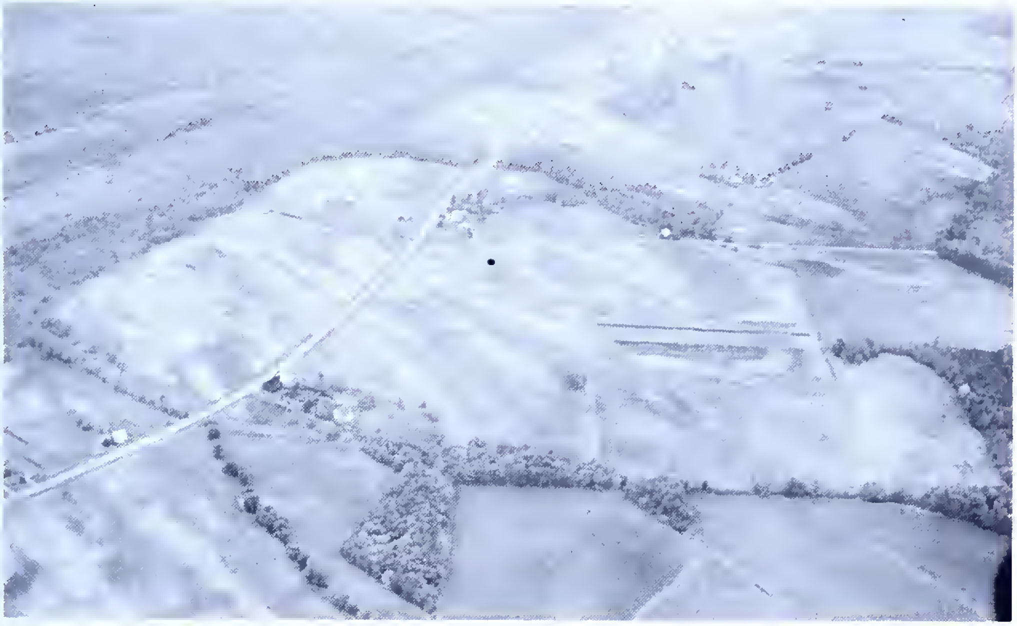

Fig. 3 Aerial photograph looking north to the parabolic dunes.

The Montandon sand deposit is typical of windblown deposits in several ways. The thickness of the deposit, as well as the size of the individual grains, decreases with distance from the source. The sand fits into the general size catagory of recent dune sands, the samples having means of sand grain diameters ranging from .06 to 1.0 mm. The surfaces of the individual grains are frosted due to the effects of wind transport, and the grains range in shape from angular to subangular. 85% of the sand is composed of quartz, the remaining 15% being made up of rock fragments and heavy minerals.

Other features occurring in the same area as the dunes include an upper loess (windblown silt) layer, and some small sand-blasted boulders (ventifacts), all of which confirm a windblown origin. The ventifacts are the remains of an earlier, Pre-Wisconsinan till of which the finer particles were partially removed by the wind, leaving the larger pebbles and boulders as a lag deposit smoothed by the windblown sand.

Wind direction is estimated by measuring the orientation of the long axis of the parabolic dunes (Figure 2). These measurements show that the major effective wind was from the northwest, with minor fluctuations from the southwest. The ventifacts, created by windblown sand abrasion, indicate strong winds as well as a lack of significant vegetative cover.

The exact climatic conditions that formed the deposit are more difficult to establish. The dunes may quite possibly have formed during a post-Pleistocene arid period when the region had a steppe-like climate. However, aridity is not a necessary factor in dune building because, as stated before, the down-cutting of the river provided ample dry sediment for the wind to work (Cooper 1942). Parabolic dunes form today in moist climates, in Oregon and other coastal areas as well as the Alaskan tundra (Cooper 1938), so it is possible that these dunes were formed during a cool, moist climate following the retreat of the glacier. Possibly, they could have been initiated just after the retreat of the glacier, and continued building during later arid periods.

This sequence of dunes created from glacial outwash is a common phenomenon of the Wisconsinan age. Similar deposits occur along the Mississippi River in Minnesota, near other North American rivers and lakes, and throughout Europe.

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EARTH SCIENCE TEACHERS' CORNER

NEW U.S.G.S. "POPULAR GEOLOGY" SERIES PUBLICATIONS—

Ferdinand Vandiveer Hayden and the Founding of the Yellowstone National Park; (revised edition 1976); 6 x 9 booklet, 44 pp. Excellent duo-tone pictures and sketches; historical and present-day photos.

John Wesley Powell's Exploration of the Colorado River; 6 x 9 booklet, 28 pp. An abundance of historical photos, maps, and sketches of the Colorado River canyon make this booklet a valuable addition to your library.

Plain Geology; 4 x 9 pamphlet, 15 pp. In 1921, George Otis Smith, then Director of the U.S.G.S., made a plea for "Plain Geology." He felt that many geologists in their writing lost sight of their audience; that their reports were couched in words and phrases that were understandable only to other scientists. His plea was a classic and is just as applicable today as it was in 1921.

Geology of Caves; 4 x 9 pamphlet, 19 pp. Describes the geologic nature, origin, and features of caves; written in non-technical terms.

Sources of Information and Services of the U.S. Geological Survey; 4 x 9 pamphlet, 15 pp. Discusses the wide range of services and sources of information disseminated by the U.S.G.S.

Selected Bibliography on Maps and Mapping; 4 x 9 pamphlet, 7 pp. Bibliography is intended for teachers and students interested in learning more about maps.

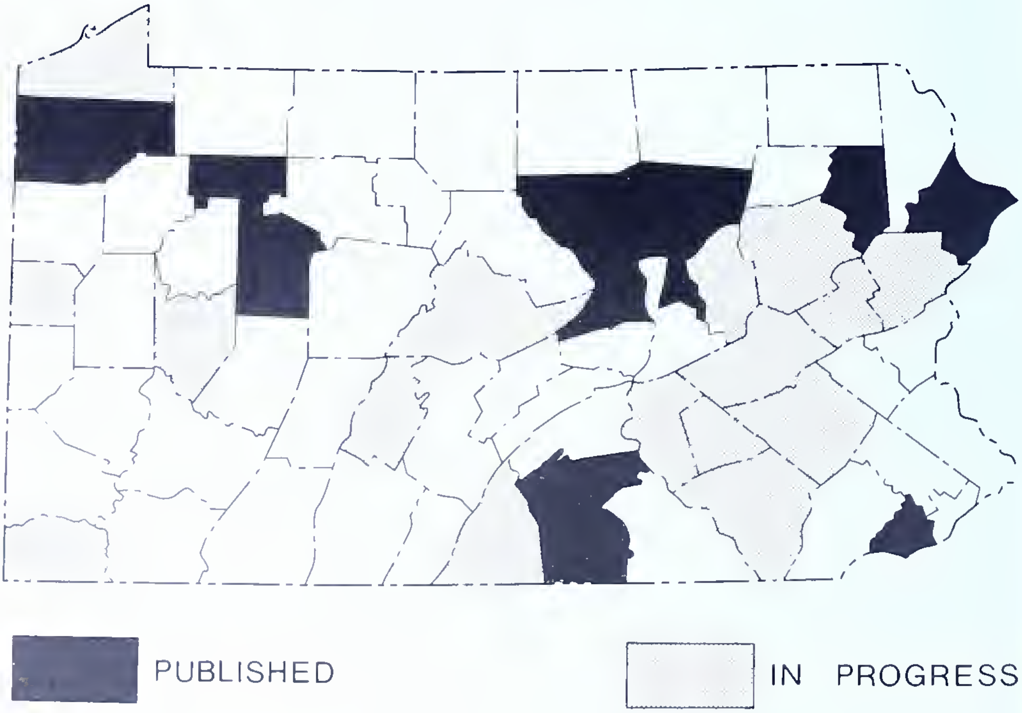
World Data Center -A- Glaciology; 4 x 9 pamphlet, 8 pp. A description of the WDC-A in Tacoma; what it is, what it has, and what it does.

Single copies of these publications may be obtained free of charge from the Branch of Distribution, U. S. Geological Survey, 1200 South Eads Street, Arlington, Virginia 22202.

Bulk quantities of Popular Publications are sold by the Branch of Distribution in Arlington, Virginia.

U.S. Geological Survey Issues New County Topographic Maps

As a product of the cooperative county mapping program with the Pennsylvania Geological Survey, the U.S. Geological Survey has recently issued new topographic maps of Adams, Crawford, Cumberland, Delaware, Lackawanna, Lycoming and Pike Counties. These new maps are at a scale of 1:50,000 (approximately 4000 ft. to the inch) and follow the previously issued maps of Union, Sullivan, Montour, Jefferson, and Forest Counties. As is standard with this new series of county maps, contours are shown in brown at 20-ft. intervals, cultural features are shown in black with major roads and urbanized areas in red, forested areas are green, water features are blue, political boundaries for county, townships, and boroughs are outlined in orange. The county map is of widespread use to all who are concerned with county and regional planning, engineering, agricultural, and recreational projects. These maps may be obtained for $2.00 each by writing to Distribution Section, U.S. Geological Survey, 1200 South Eads Street, Arlington, Virginia 22202.

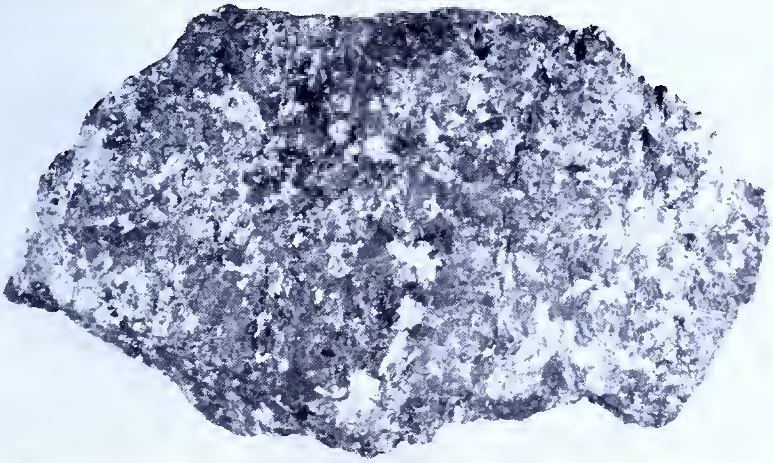


Mystery Prospects, Berks County

by Robert C. Smith II

Berks County continues to be a source of geological and mineralogic surprises (see **Pennsylvania Geology** v. 5, no. 6 on fetid barite and v. 6, no. 6 on molybdenite). Arsenic minerals, normally rare in Pennsylvania and previously unknown in the Reading Prong, have now been found and identified in moderate amounts on the dumps at a long-abandoned prospect north of Huff's Church, Hereford Township, Berks County (latitude 40° 27′ 30″ N, longitude 75° 36′ 49″ W). Almost nothing is known about the history of this prospect or its original purpose. The normally complete maps of d'Invillers (1883, sheet VI) do not show a mine or prospect at this location. Although minerals from nearby prospects are listed, S. G. Gordon's 1922 classic **Mineralogy of Pennsylvania** also does not mention the prospect. All that is known is that B. L. Miller (1912) found an unexciting amount of graphite in a gneiss composed of feldspar, quartz, horn-blende, biotite, garnet, and pyrite, and that the shaft was backfilled during the 1960's.

In addition to the arsenic species discussed below; magnetite, pyrrhotite, chalcopyrite, fayalite, almandine?, hornblende, and abundant graphite are present on the dumps. The arsenic mineral occurs as tin white, metallic blebs up to 1/2 inch and veinlets up to 1/8 inch x 1-1/2 inches, and yields X-ray spacings which suggest



Rock from prospect at Huff's Church containing safflorite (silvery) with pyrrhotite (gray) in hornblende (black). Specimen is 3.5 inches.

that the mineral is safflorite. Safflorite, however, is reported to be a cobalt arsenide, whereas the mineral from Huff's Church contains iron and arsenic with only traces of cobalt. Thus, the unit cell (a=5.23Å, b=5.972, and c=2.928 all ± 0.005) does not fit the presumed $FeAs_2$ composition and the mineral could be called either safflorite or loellingite, depending on whether the importance is placed on atomic structure or chemical composition. Either of these would, however, be a new mineral species for the state.

Assays of a bulk sample derived from almost 50 pounds of one-inch chips each containing at least traces of the white arsenic mineral show that the "ore" contains 1.03% As, 0.13% Cu, 340 ppm (0.034%) Ni, 150 ppm Co, 50 ppm Zn, 30 ppm Pb and Bi, 20 ppm Sn, 0.48 oz Ag/ton, and 0.016 oz Au/ton. Of these, the As content is quite high, and the Cu, Ag, and Au slightly high. At present prices, the latter three would have a total value of about $5.75 per ton, far too low to be mined profitably for an apparently small "orebody." Even the rich magnetite matrix presently has little value in deposits with less than 10 million tons. Was the mystery shaft dug for iron, copper, silver, gold, graphite, or even the shiny white arsenic mineral? At least, the form and amount of arsenic present are probably not harmful.

The host rock has been mapped as a Precambrian hornblende graphite gneiss (Buckwalter, 1959). Bromery et al. (1959) show aeromagnetic anomalies less than a mile to the east. Many pieces of "ore" (magnetite-pyrrhotite-rich rock) are slickensided, suggesting faulting in the area. Analyses of a few stream sediment samples from within a mile of the prospect failed to find any obvious continuation of copper mineralization.

The prospect was kindly brought to our attention by James L. Quickel of Carlisle. Qualitative chemical tests showing the absence of Co were furnished by D. T. Hoff of the William Penn Memorial Museum, and SEM analyses showing iron and arsenic were obtained through Donald Schmerling, Chemetron Corp. Each has contributed because of his interest in Friends of Mineralogy, Pennsylvania Chapter's role in advancing knowledge of minerals in the Commonwealth.

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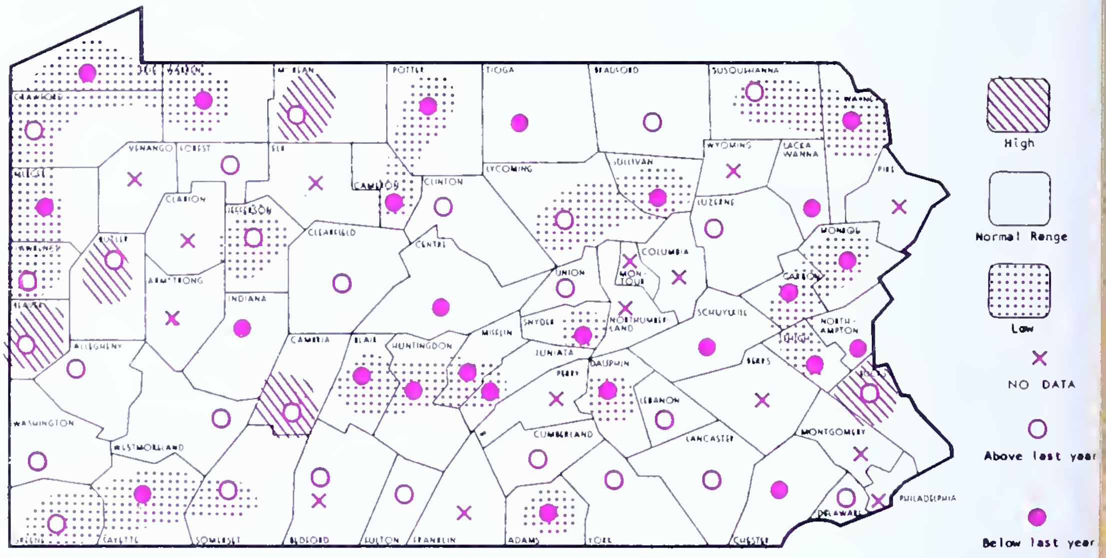

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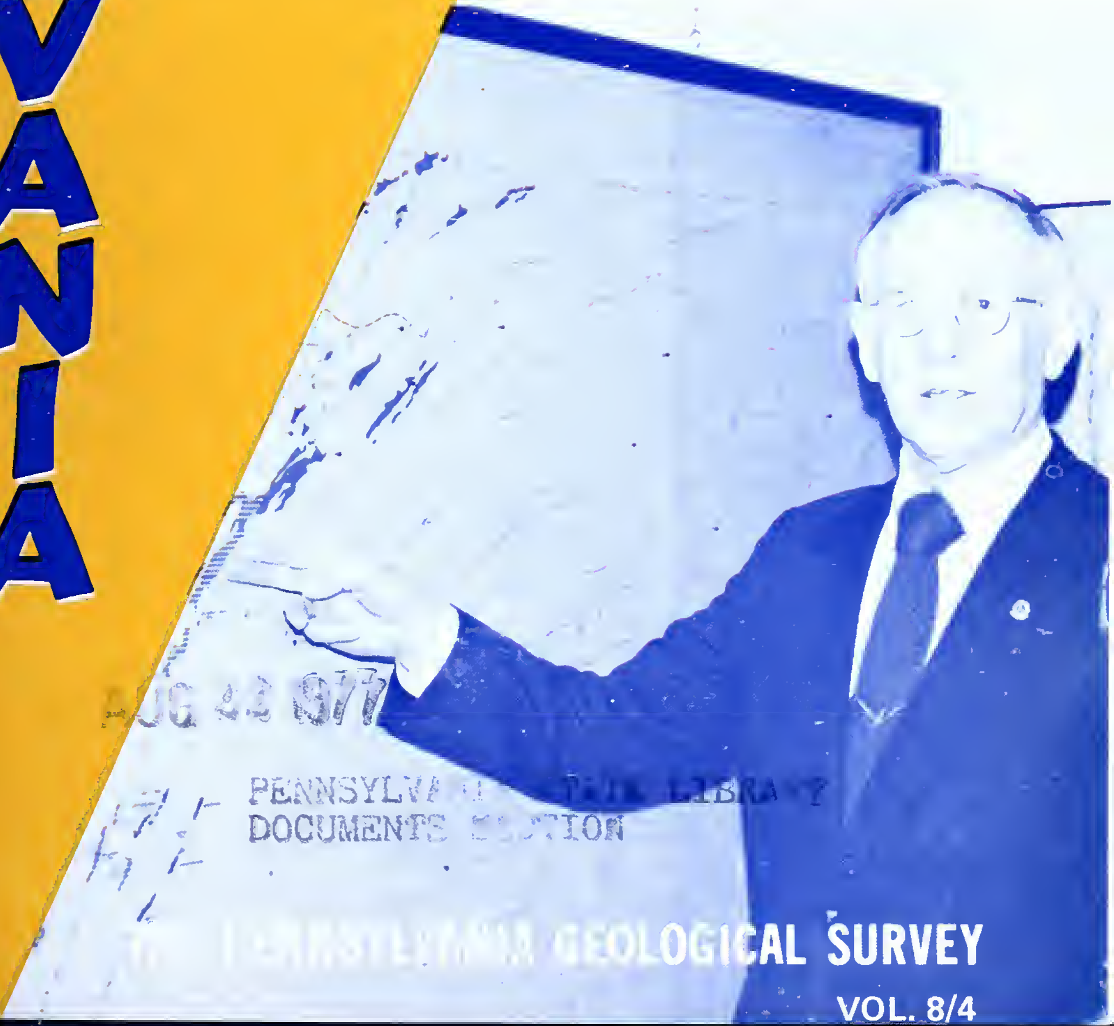

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THE PENNSYLVANIA GEOLOGICAL SURVEY

VOL. 8/4

GEOLOGICAL RESEARCH IN PENNSYLVANIA 1977

INTRODUCTION

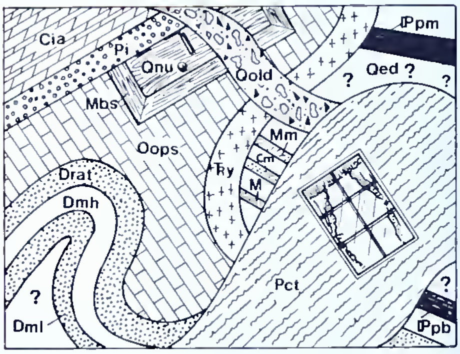
This publication is the twentieth annual report on Geological Research and Publications in Pennsylvania. This is an attempt to list all current geologic research in Pennsylvania and includes persons and projects other than those of the Pennsylvania Geological Survey. Because of the extensive response and large number of projects reported to us, we have had to exercise editorial license to reduce the description of the research projects to fit our available space. We have also attempted to determine an anticipated completion date (ACD) for each project. The anticipated completion date is the estimate of the date when the author will complete his report; additional time for publication should be projected.

The listings are grouped into major categories of research to facilitate your search for information on a particular subject. Publications in press are listed by author.

As with all compilations, there may be omissions; this is unintentional. Additional copies of this report may be obtained by writing to the Bureau of Topographic and Geologic Survey, Department of Environmental Resources, Harrisburg, Pennsylvania 17120.

RESEARCH IN PROGRESS

AREAL GEOLOGY



T. M. BERG, A. A. SOCOLOW, D. M. HOSKINS, A. R. GEYER, S. I. ROOT, W. E. EDMUNDS, D. B. MacLACHLAN, W. D. SEVON, and A. D. GLOVER, Pa. Geol. Survey. Revision of Pennsylvania State Geologic Map. Compilation work for the new state geologic map is complete. Approximately one fourth of the state has been newly mapped and published since the 1960 revision. Approximately one half of the state has been revised by these methods: 1) extrapolation into adjacent areas from the new, post-1960 mapping; 2) extensive aerial photo interpretation, backed up by field checking and reference to Survey files; 3) adjustment of contacts to fit new 1:24,000 topographic maps; and 4) inclusion of much unpublished work contributed by geologists from industry, academic institutions, and government agencies. Approximately one fourth of the state will show no change or will show nomenclatural change only. Remaining work to be done is primarily editorial. ACD: Late 1977 or early 1978.

M. J. BERGIN, U. S. Geol. Survey. Northern Anthracite Field. This year's work will consist of geologic map compilation for Kingston, Pittston, and Wilkes-Barre West quadrangles. ACD: Continuing.

J. B. EPSTEIN, U. S. Geol. Survey. Wind Gap and Adjacent Quads. Continue map and report preparation and field work in the Saylorsburg quad. ACD: 1977.

A. D. GLOVER, J. H. WAY, JR., and R. T. FAILL, Pa. Geol. Survey. Geology and Mineral Resources of the Altoona 15′ Quad., Blair, Cambria, Clearfield, and Centre Cos., Pa. Encompasses mapping of bedrock units (Cambrian to Pennsylvanian age), structures (Nittany anticline, Appalachian Front, Allegheny Plateau and associated thrust, wedge, and strike-slip faults) and surficial deposits (alluvium and colluvium) with discussions of minerals, economic deposits (primarily coal), and engineering properties. ACD: 1978.

LOUIS HEYMAN, Pa. Geol. Survey. Subcrop beneath the Onondaga-Huntersville-Bois Blanc Formations in the Subsurface of Western Pa. The above units overlie, with increasing unconformity, rocks from Lower Devonian to the south to Upper Silurian in the north. The pattern may delineate otherwise concealed deeper structure and hydrocarbon traps. ACD: 1978.

J. D. INNERS, Pa. Geol. Survey. Geology and Mineral Resources of the Berwick Quad., Luzerne and Columbia Cos., Pa. ACD: 1977.

J. D. INNERS, Pa. Geol. Survey. Geology and Mineral Resources of the Bloomsburg and Mifflinville Quads., Columbia Co., Pa. ACD: 1980.

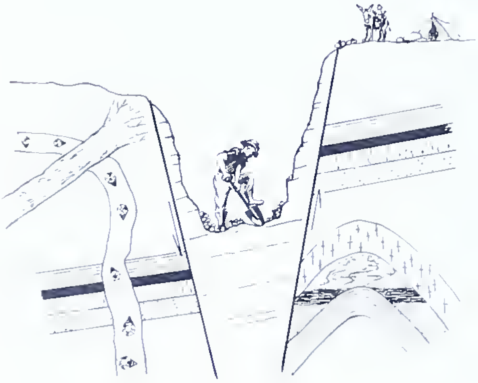
W. D. SEVON, Pa. Geol. Survey. Surficial Map of Pa. (1:1,000,000). Generalized map of gross surficial units throughout the state (compiled at 1:250,000 for reduction to 1:1,000,000). ACD: May 1977.

W. D. SEVON and T. M. BERG, Pa. Geol. Survey, and L. SCHULTZ, Gilbert Assoc. Geology and Mineral Resources of Pike Co., Pa. Bedrock and surficial maps, structure cross sections, photographs, environmental, engineering, economic, and ground-water interpretations, microscopic petrology, described sections, and brief text. ACD: May 1978.

S. I. ROOT, Pa. Geol. Survey. Geology and Mineral Resources of the Mechanicsburg and Carlisle Quads., Pa. ACD: 1977.

R. B. WELLS, Pa. Geol. Survey, and M. F. BUCEK, H. R. B. Singer, Inc. Geology and Mineral Resources of Montoursville North and Huntersville Quads., Lycoming Co., Pa. Geologic mapping of Lower Devonian through Lower Pennsylvanian bedrock formations and Pleistocene and Recent surficial materials, sampling and analysis of units with possible economic potential, description and evaluation of environmental and engineering characteristics of rock units. Report will include both bedrock and surficial geologic maps, cross sections, and a brief text. ACD: June 1977.

G. H. WOOD, JR., U. S. Geol. Survey. Southern Anthracite Field. Continue to compile and interpret geologic and coal maps on the stratigraphy, structure, depositional environments, sedimentology, and correlation of Silurian to Pennsylvanian age rocks. ACD: Continuing.



ECONOMIC GEOLOGY

P. C. BAZAKAS, The Pa. State Univ. at Ogontz. Lineament Analysis of Southeastern Pa. and N. J. in Relation to the Location of Ore Deposits. Analysis of lineaments of various scales using ERTS (now Landsat-1) and Skylab scenes. Correlation with known ore deposits, prospects, and mineral sites.

J. L. CRAFT, Pa. Geol. Survey. Evaluation of Gravel Quality Problems, Upper Allegheny River, Northwest Pa. A field and laboratory study of the gravel quality problems related to gravel terrace operation in the Upper Allegheny River. Field observation and laboratory testing show quality gravel does exist in those outwash terrace deposits, but special care has to be used during excavation to remove upper weathered material prior to plant processing. ACD: Summer 1977.

WALLACE de WITT, JR., G. E. CLAYPOOL, G. W. COLTON, THADDEUS DYMAN, A. C. HARRIS, L. D. HARRIS, J. W. HOSTERMAN, J. S. LEVANTHAL, W. J. PERRY, JR., J. B. ROEN, J. W. SCHMOKER, and L. G. WALLACE, U. S. Geol. Survey. Shale Characterization and Resource Appraisal of Devonian Black Shale in the Appalachian Basin. The U. S. G. S. Shale Characterization and Resource Appraisal Program is part of ERDA's Eastern Gas Shales Project. The U. S. G. S. effort includes projects in stratigraphy, structure, geochemistry, geophysics, paleontology, economic geology. ACD: 1981.

A. F. JACOB, U. S. Geol. Survey. Basin Analysis of Uranium-Bearing Paleozoic Rocks of Eastern United States. Reconnaissance of Paleozoic delta systems in central and southern Appalachian Basin will be completed, and a map of uranium occurrences in Paleozoic sedimentary rocks of the Appalachian Basin will be compiled. Work will then begin on the depositional systems, stratigraphy, and petrology of a selected Paleozoic delta system. ACD: 1980.

DENNIS MAHAR and A. W. ROSE, The Pa. State Univ. Geology and Geochemistry of Copper-Uranium Occurrences, Lycoming and Sullivan Cos., Pa. Copper and uranium occur in organic debris in the bottom of channels in the Catskill Formation of the area. Uranium in stream sediment of a drainage basin near Beaver Lake is a close approximation to average soils in the drainage, so that possibilities for mineralization can be semiquantitatively appraised. ACD: June 1977.

B. J. O'NEILL, JR., and Field Division, Pa. Geol. Survey. Investigations for High-Calcium Limestones in Pa. Objectives of investigation are: 1) to sample and analyze limestone units where information is lacking, incomplete, or widely scattered; 2) to map any newly discovered high-calcium unit that has a potential for commercial extraction; and 3) to synthesize the data into a publication which can be used as a guide to exploration targets. ACD: Continuous program.

B. J. O'NEILL, JR., and J. H. BARNES, Pa. Geol. Survey, and KENNETH LILES, U. S. Bur. Mines. Properties and Uses of Clays and Shales in South-Central Pa. A continuation of the series of programmed studies to evaluate the economic potential of clay-shale raw materials for ceramic and non-ceramic uses. ACD: 1979.

B. J. O'NEILL, JR., and J. H. BARNES, Pa. Geol. Survey, and KENNETH LILES, U. S. Bur. Mines. Properties and Uses of Clays and Shales in Southwestern Pa. A continuation of the series of programmed studies to evaluate the economic potential of shale-clay raw materials for ceramic and non-ceramic uses. ACD: Dec. 1977.

R. G. PIOTROWSKI and S. A. KRAJEWSKI, Pa. Geol. Survey. Stratigraphic Relations of the Devonian Organic-Rich Shales in the Subsurface of Western Pa. This project is a portion of the resource evaluation phase of ERDA's eastern shale gas project. The study will include stratigraphic cross sections, facies distribution maps, and regional structural maps for the Upper and Middle Devonian clastics in western Pa. with special emphasis on the potential gas-producing Devonian organic-rich shales. ACD: July 1978.

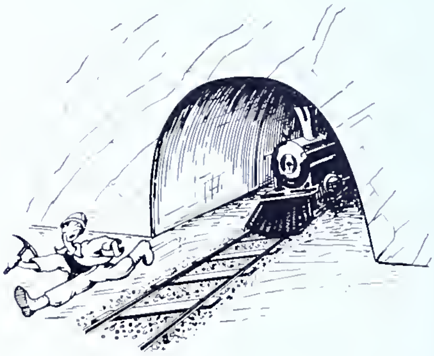
V. W. SKEMA and W. E. EDMUNDS, Pa. Geol. Survey. Economic Geology of the Upper Freeport Coal in Northeastern Greene Co., Pa. Relation of stratigraphy, sedimentology, depositional environment, and structure to the economic geology of the Upper Freeport coal and associated rocks in northeastern Greene Co. ACD: Dec. 1977.

R. C. SMITH, II, Pa. Geol. Survey. Trace Element Content of Sphalerite and Galena from Pa. Pure mineral concentrates of sphalerite and galena will be analyzed by atomic absorption, X-ray fluorescence, and fire assay for such elements as Mn, Fe, Co, Ni, Ga, Ag, Cd, In, Sn, and Bi. The analyses will be evaluated for by-product, pathfinder, genetic, and environmental significance. ACD: Feb. 1978.

SCOTT TREGASKIS and A. W. ROSE, The Pa. State Univ. Geology and Geochemistry of Zinc-Lead Occurrences in Morrison Cove, Bedford Co., Pa. Sphalerite and galena occur in brecciated Cambro-Ordovician carbonates along a complex thrust zone near Woodbury, Pa. Fluid inclusions indicate deposition from extremely saline brines at 120-170°C. Several pertinent methods of geochemical exploration are evaluated. ACD: Dec. 1977.

C. E. TURNER, U. S. Geol. Survey. Basin Analysis as Related to Uranium Potential in Triassic Sedimentary Rocks, Eastern United States. Complete preparation of location map for uranium occurrences in Triassic rocks, and field work in Newark-Gettysburg basin. Report writing on environmental interpretations of Stockton, Lockatong, and Brunswick Formations, and study to determine mineralogy of uranium sandstones and shales from Newark-Gettysburg basin will begin. ACD: 1977.

ENGINEERING GEOLOGY



W. R. ADAMS, JR., NEIL DUBROVSKY, and JOHN ONEACRE, Allegheny County Works Dept. Demonstration Program of Geotechnical Services [Allegheny Co.]. Geotechnical services will include: 1) establishment of "hot line" for people affected by geologically related hazards, 2) referral to sources of technical and/or financial assistance, 3) data bank of geotechnical information accessible to the public, and 4) educational seminars. ACD: 1980.

W. R. ADAMS, JR., and E. W. VASKOV, Allegheny County Works Dept. An Improved Approach to Managing Land Use Based on Analysis of Geological Hazards in Allegheny Co. Analysis of previous landslide history in Allegheny County, preparation of model ordinances to control development in slide prone areas, and education of municipal officials of need for adoption of these ordinances. ACD: Dec. 1977.

W. E. DAVIES, G. C. OHLMACHER, J. S. POMEROY, ANNABEL OLSON, ROBERT HACKMAN, and P. J. RUANE, U. S. Geol. Survey. Strip Mine Areas in the Appalachians [Pa.-Ala.]. Inventory mapping of existing strip mines as to type and degree of reclamation on 7-1/2′ quadrangles. Publication of 1:250,000 map series showing active strip mines, type of reclamation, and geologic problems of potential strippable coal. Canton sheet is now being compiled from observations incidental to landslide studies. ACD: Dec. 1978 for western Pa.

S. S. HARRISON, Allegheny Coll. Effects of Oxidation/Reduction on the Physical Properties of Fine-Grained Glaciolacustrine Sediments [Crawford Co.]. Fine-grained glaciolacustrine sediments exposed in Woodcock Creek valley exhibit sharp oxidation/reduction boundaries, as evidenced by a change from brown to gray color. Preliminary examination suggests that the physical properties of these sediments is greatly affected by the oxidation state. Further tests will involve determination of Atterberg limits. ACD: Mar. 1978.

S. S. HARRISON, Allegheny Coll. Relationship of Atterberg Limits of Fine-Grained Glaciolacustrine Sediments to State of Oxidation. Field examination of oxidized and unoxidized fine-grained glaciolacustrine sediments suggests that the unoxidized sediments are generally more plastic and less stable. A detailed lab study is being conducted to test this observation. ACD: June 1978.

G. L. MERRITT, Pa. Dept. Environ. Resources, and W. A. DUVEL, JR., and R. J. McLAREN, Michael Baker, Jr., Inc. Feasibility Study: The Use of FGD Scrubber Sludges and Fly Ash to Abate Drainage Emanating from Abandoned Deep Mines and to Prevent Mine Subsidence [western Pa.]. ACD: Apr. 1978.

J. S. POMEROY, W. E. DAVIES, ANNABEL OLSON, ROBERT HACKMAN, P. J. RUANE and G. C. OHLMACHER, U. S. Geol. Survey. Landslide Studies [coalfields of Appalachians, Pa.-Ala.]. Inventory mapping of slope stability conditions on 7-1/2′ quadrangles. Publication of 1:250,000 maps of slope stability. Canton sheet ready for publication in October 1977; Pittsburgh and Clarksburg sheets ready at end of 1977. ACD: Dec. 1978 for western Pa.

J. B. URBAN, W. J. GBUREK, JAMES HOOVER, and WALTER HEALD, U. S. Dept. Agric. Storm Water Detention and Ground-Water Recharge Using Porous Asphalt [SE Pa.]. A research site containing three 150′ x 150′ plots is being constructed. The plots are porous asphalt, conventional asphalt, and grass. Runoff, soil moisture, ground water, and meteorological and water quality measurements are used to monitor hydrologic effects and validate design criteria. ACD: 1982.

J. P. WILSHUSEN, Pa. Geol. Survey. Geologic Hazards in Pa. A descriptive report illustrated with maps, photographs, and sketches outlining the occurrence of geologic hazards in Pa. Natural geologic hazards in this state are 1) landslides and related phenomena, 2) sinkholes and solution phenomena, and 3) earthquakes. Each is discussed as a naturally occurring hazard and then in relation to the activities of man. ACD: July 1977.

ENVIRONMENTAL GEOLOGY

R. B. FINKELMAN, U. S. Geol. Survey. Release of Toxic Trace Elements from a Burning Bituminous Culm Bank [Mather, Pa.]. ACD: June 1977.

N. K. FLINT and DARL ROSENQUEST, Univ. of Pitt. Geologic hazard mapping in Squaw Run Area Watershed, Allegheny Co. Field mapping of both historic and prehistoric landslides at a scale of 1 in.=

200 ft. will begin in May 1977 as part of a comprehensive study of this watershed. The area lies mostly in O'Hara Twp. and Fox Chapel Boro. ACD: 1978.

S. S. HARRISON and DAN DOYLE, Allegheny Coll. Effects of Road Salt on the Salinity of Mill Run [Crawford Co.]. Mill Run, which passes through the center of Meadville, receives the discharge of many of the city's storm sewers. The chloride concentration in the stream exceeded 2000 mg/l during a thaw. This is equivalent to over 1-1/2 tons per day with a stream discharge of 12 cfs. ACD: Completed.

P. M. HUNTER and R. R. PARIZEK, The Pa. State Univ. The Environmental Geology of the Pine Grove Mills-Stormstown Area, Central Pa., with Emphasis on the Bedrock Geology and Ground-Water Resources. ACD: Mar. 1977.

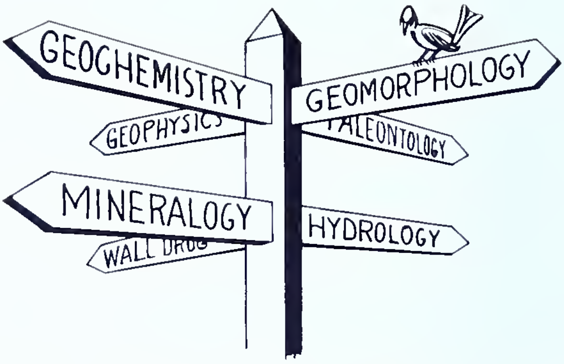
M. M. MARTIN and R. R. PARIZEK, The Pa. State Univ. Prediction of Acid-Mine Drainage Quality [western Pa.]. Field work is presently being started with the objective to relate acid-mine drainage quality to age and type of mine restoration and the chemical and petrographic characteristics of the coal overburden. ACD: Aug. 1978.

R. R. PARIZEK, E. G. WILLIAMS, and R. J. HORNBERGER, The Pa. State Univ. Delineation of Acid Mine Drainage Potential of Coal-Bearing Strata of the Pottsville and Allegheny Groups in Western Pa. A regional data base consisting of water quality parameters, coal-mining patterns, and geologic factors is being assembled. Computer mapping techniques are being employed in the analysis and graphic display of the data. ACD: Mar. 1978.

H. A. TOURTELOT, U. S. Geol. Survey. Pollution Studies [Pa. subunit — metropolitan Pittsburgh, the city of Washington and environs; and Keystone power plant, Shelocta]. Relatively large amounts of arsenic, copper, mercury, tin, and zinc in surficial materials are consistently associated with the areas of most intense commercial and technological activities within the cities, compared to amounts in the surrounding countryside. Work on the Keystone power plant awaits completion of analyses of plant samples. ACD: 1978.

J. P. WILSHUSEN, Pa. Geol. Survey, and M. E. HORNE, Consultant. Greater York Area Environmental Geology. A compilation of geologic information pertinent to the development and environmental protection of the greater York area, composed predominantly of maps with interpretive legends discussing geology, water resources, mineral resources, and engineering characteristics of bedrock and soils. ACD: Nov. 1977.

GENERAL GEOLOGY



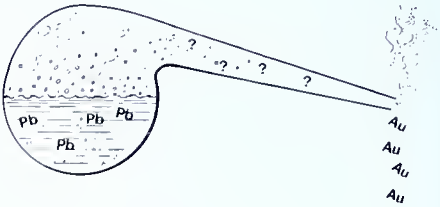
T. A. HEFFNER, Syracuse Univ. Quantitative Analysis of the Coatesville Pegmatite and Pyrrhotite Localities [Chester Co.]. Multivariate statistics, edge enhancement, and other geomathematical techniques are employed to map a mostly covered area. The data base includes magnetic intensity, gamma-ray spectra, and soil composition. ACD: June 1977.

A. R. GEYER, Pa. Geol. Survey, and **W. H. BOLLES**, Pa. Dept. Educ. Outstanding Geologic-Scenic Features of Pa. Outstanding geologic-scenic features cataloged are those with values of such distinctive quality as to be of county, state, or national significance. About half of the 165 identified have been photographed and investigated. ACD: Dec. 1977.

S. G. KHOURY, J. WALLACH, and **J. E. TILLMAN**, Dames & Moore. Detailed mapping in southern Lancaster Co. led to the reclassification of the Glenarm as a supergroup which comprises, in addition to the Setters and Cockeysville Formations, the formations and members of the Wissahickon Group. Mapping lithologies according to these newly developed subdivisions resulted in the definition of a previously unrecognized major fold, the Drumore fold. It is the outline of the Drumore fold and not the Peach Bottom fold that is expressed on remote sensing imagery. ACD: Completed.

J. P. WILSHUSEN and **S. I. ROOT**, Pa. Geol. Survey. Geology of the Appalachian Trail in Pennsylvania [SE Pa.]. A general geologic description of individual, prominent features of geologic origin on and near the Appalachian Trail in Pa.; illustrated with maps, sketches, and photographs.

GEOCHEMISTRY



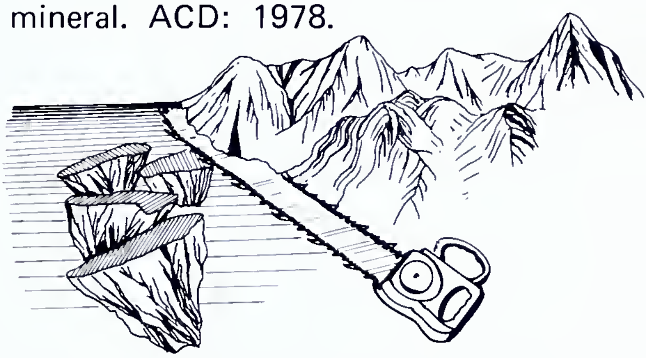
M. L. CRAWFORD, Bryn Mawr Coll., and M. E. WAGNER and J. P. HANDY, Univ. of Pa. Chemical and Mineralogical Study of Metaigneous Rocks, Pa. and Md. Piedmont. This project involves a detailed chemical and mineralogical study of several different groups of mafic metaigneous rocks of the Piedmont in an attempt to determine whether the different groups are related to each other in age and/or tectonic setting. ACD: 1979.

A. W. ROSE and L. A. KORNER, The Pa. State Univ. Radon in Ground Waters as a Guide to Uranium Ores [NE Pa.]. High contents of radon occur in ground waters near areas of uranium occurrences. Near Jim Thorpe, radon is a better guide than uranium in ground waters. ACD: June 1977.

A. W. ROSE and SIMON PIRC, The Pa. State Univ. Geochemical controls of uranium in Devonian sedimentary rocks of eastern Pa. Relations of U to major and minor elements in sandstones and shales of the Upper Catskill are being studied in order to identify anomalously high or low stratigraphic zones or regions which can then be related to origin of uranium deposits, and used as guides to favorable areas. ACD: 1978.

H. A. TOURTELOT, U. S. Geol. Survey. Lithium in High-Alumina Materials [Pa. subunit]. Underclays in western Pa. contain as much as 300 ppm lithium, and flint clays in central Pa. contain as much as 2000 ppm lithium. The lithium may be incorporated in the kaolinite structure of the underclays and some flint clays, but it seems possible that the lithium in the highly enriched flint clays is contained in a hitherto unrecognized lithium mineral. ACD: 1978.

GEOMORPHOLOGY

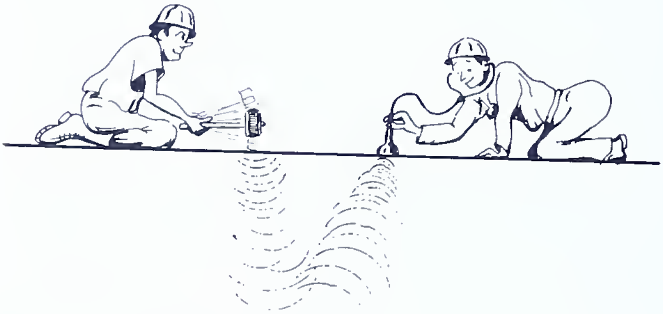


S. S. HARRISON, RON MOROSKY, and MIKE McSTRAW, Allegheny Coll. Relationship of Channel Morphology and Geometry to Lithology of Channel Sediments [Elk Creek, Erie Co.]. The upper reaches of Elk Creek cut through drift; the lower reaches are incised in bedrock. Channel morphology and geometry, measured in the field and on air photos, will be compared in these two reaches. ACD: June 1978.

S. S. HARRISON and JASON COX, Allegheny Coll. Relationship of Stream Segment Orientation to Fracture Traces [Crawford Co.]. A quantitative assessment of the relationship between the orientation of stream segments and fracture traces is being made. Separate tabulation will be made of first, second, third, and fourth order streams. ACD: June 1977.

W. B. WHITE, The Pa. State Univ. Caves of Pa. The object is to compile a complete catalog of the known caves of Pa. Compilation of the caves in the Valley and Ridge portion of the state is now underway. ACD: 1980.

W. B. WHITE and E. L. WHITE, The Pa. State Univ. Geomorphology of the Appalachian Karst [Pa. to Ala.]. The objective is a detailed study of karst landforms in the entire Appalachian chain, including quantitative landform analysis and detailed descriptions of specific areas of interest. Work is currently underway on the landforms and drainage of the carbonate valleys of central Pa. ACD: 1984.



GEOPHYSICS

D. L. CAMPBELL, U. S. Geol. Survey. Geophysical Studies Relating to Uranium Deposits in Crystalline Terranes. Analysis and report writing of data from electrical resistivity soundings in the Gettysburg Triassic basin will be completed. ACD: 1979.

J. R. KUSIAK and P. M. LAVIN, The Pa. State Univ. A Gravity and Magnetic Interpretation of the Structure and Deformational History of the Jacksonwald Syncline, Berks Co., Pa. Magnetic modelling, accounting for the remanent magnetization, indicates that the Jacksonwald still was emplaced horizontally and subsequently folded and tilted. ACD: May 1977.

C. K. SCHARNBERGER, Millersville State Coll. Detailed Magnetic Survey of the Martic Contact [southern Lancaster Co.]. ACD: Late 1978 or early 1979.

C. K. SCHARNBERGER, Millersville State Coll., and SHELTON ALEXANDER, The Pa. State Univ. Pennsylvania Seismic Network [Pa.-Md.-Del.-N.J.]. The Millersville seismic station has received an official designation from the U.S.G.S. (MVL) and has recorded several small N.J. earthquakes and explosions in quarries as far away as Bellefonte, Pa. ACD: Ongoing.

ROB VAN DER VOO and DOYLE WATTS, Univ. of Mich. Lower Paleozoic Magnetism of North America. This is part of a continuing project in which we are investigating the characteristic magnetic directions of lower Paleozoic sedimentary units of North America. In Pennsylvania, we are concentrating our efforts on the Waynesboro Formation. ACD: Aug. 1978.

K. W. VOLK, P. M. LAVIN, and A. W. ROSE, The Pa. State Univ. Late Triassic-Jurassic Deformation of the Gettysburg and Western Newark Basins of Southeastern Pa. Variations of the remanent magnetism of Mesozoic intrusives show that intrusion of York Haven-type diabase was followed by regional tilting (10° NW), intrusion of Rossville-type diabase, continued regional tilting (15° NW) and folding confined to the basins. ACD: May 1977.

ISIDORE ZEITZ, U. S. Geol. Survey. Regional Aeromagnetic Studies of United States. The Pennsylvania aeromagnetic map is being prepared for publication. ACD: 1978.

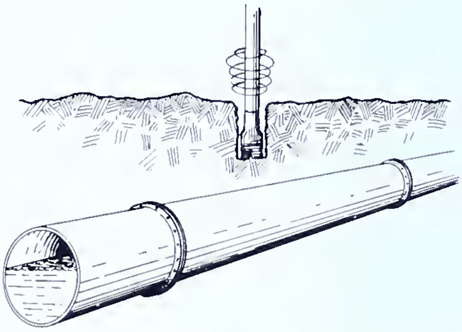
GLACIAL GEOLOGY

G. H. CROWL, Ohio Wesleyan Univ. The Wisconsinan Glacial Border in Pa. [Potter, Tioga, and Lycoming Cos.]. The border has been mapped from Ceres on the N. Y. State line southeast to Pine Creek gorge; the area from here to Trout Run remains to be completed. The age, early or late Wisconsinan, is uncertain. ACD: 1978.

S. S. HARRISON and CHUCK BRAYMER, Allegheny Coll. Environment of Deposition of Kame-Like Deposits [Crawford Co.]. Primary sedimentation structures and syn- and post-depositional structural features will be studied in kame-like deposits near Conneaut Lake. A detailed reconstruction of the environment of deposition will be attempted. ACD: June 1978.

FRANK NEHER and E. B. EVENSON, Lehigh Univ., and W. D. SEVON, Pa. Geol. Survey. A Quantitative Differentiation of the Glacial Drift of Northeastern Pa. Investigation of the three distinct drift sheets (Illinoian, Altonian, Woodfordian) with respect to degree of weathering as an indicator of relative age. Quantifiable parameters include: 1) depth and character of soil profile development, 2) the clay mineral alteration sequence of each unit, 3) amorphous iron, and 4) the weathering and alteration of the heavy mineral suite.

HYDROLOGY



E. D. HESS, Pa. Geol. Survey. Water Well Inventory [Pa.]. Identification of lithologic units, positioning of wells by coordinates, and analysis of rock units as potential aquifers. ACD: Ongoing.

L. J. McGREEVY and R. A. SLOTO, U. S. Geol. Survey. Ground-Water Resources of Chester Co., Pa. A general ground-water resource evaluation has been completed. Work is continuing to develop the capability of estimating effects of altering the hydrologic system. ACD: July 1978.

S. I. ROOT, Pa. Geol. Survey, and A. E. BECHER and W. WETERHILL, U. S. Geol. Survey. Geology and Ground-Water Resources of the Great Valley, Cumberland Co. ACD: 1977.

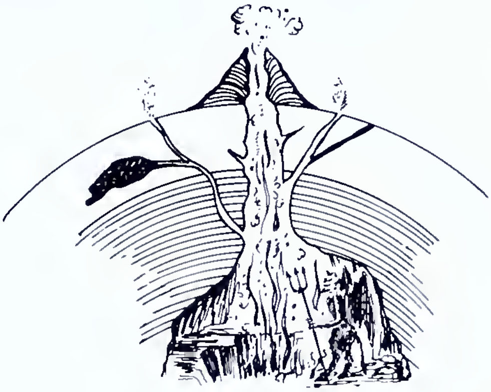
S. I. ROOT and L. E. TAYLOR, Pa. Geol. Survey, and A. E. BECHER, U. S. Geol. Survey. Geology and Ground-Water Resources of the Great Valley, Franklin Co. ACD: 1978.

REGINAL SPILLER and R. R. PARIZEK, The Pa. State Univ. Statistical Analysis of Well Yields as Related to Fracture Traces. ACD: June 1978.

E. L. WHITE and W. B. WHITE, The Pa. State Univ. Hydrology of Carbonate Rock Basins [central and eastern Pa.]. The objective is the interpretation of ground-water and surface-water flow in basins underlain by carbonate rocks. This includes ground-water recharge and discharge, flood flow behavior, and sustained flow. ACD: Indefinite.

D. A. STEFFY and H. W. RAUCH, W. Va. Univ. The Effect of Photo-Lineaments and Structural Geologic Variables on Water-Well Yield in the Carbonates of Conestoga Valley, Lancaster Co., Pa. Project based on raw data from Meisler and Becher (1973) and on photo-lineaments mapped by Steffy. Only those carbonate aquifers displaying high contents of insoluable impurities exhibit an effect of photo-lineaments on the yields of nearby wells. High well yields were found for wells in areas of high bedding dip and high cleavage dip, and for wells close to faults and in limestone beds. ACD: May 1977.

IGNEOUS AND METAMORPHIC PETROLOGY



F. E. DEMMON, III, and W. A. CRAWFORD, Bryn Mawr Coll. Investigations of the Origins and Metamorphic History of Precambrian Gneisses in the Downingtown 7-1/2′ Quad., SE Pa. Gneisses of the Honey Brook Uplands in the Downingtown 7-1/2′ quad. are being remapped and current terminology applied to them. Petrographic and geochemical techniques are being used to determine their geologic history and pre-metamorphic parents. ACD: May 1977.

A. A. DRAKE, JR., and R. I. TILLING, U. S. Geol. Survey. Petrochemistry and Radiogenic Heat Producing Minerals of Reading Prong Rocks [Pa.-N. J.-N. Y.]. Collecting will be done in northeasternmost N. J., eastern N. Y., and Little South Mountain, Pa. Preliminary work suggests that hornblende-granite-alaskite suite has high heat productivity values and that sodic metasedimentary-metavolcanic rocks have unusual Th/U ratios. ACD: 1981.

W. F. THOMANN and W. A. CRAWFORD, Bryn Mawr Coll. Igneous and Metamorphic Petrology of the Honey Brook Uplands [Elverson, Pottstown, and Phoenixville 7-1/2′ quads., SE Pa.]. Granulite facies metamorphism was followed by incomplete amphibolite facies metamorphism. Two major suites of rocks are: 1) granulite gneisses (meta-plutonic rocks), 2) hornblende granulites, felsic amphibolite gneisses (metavolcanics), and graphitic granulite gneisses (metasediments). ACD: May 1977.

MINERALOGY

J. H. BARNES, Pa. Geol. Survey, and **W. F. DOWNEY, JR.**, Juniata Coll. Mineralogy Associated with Burning Anthracite Deposits [Luzerne, Schuylkill, N. Dauphin Cos.]. Study of minerals forming from sublimation of gases produced by subsurface fires in anthracite mines and culm banks. ACD: 1977.

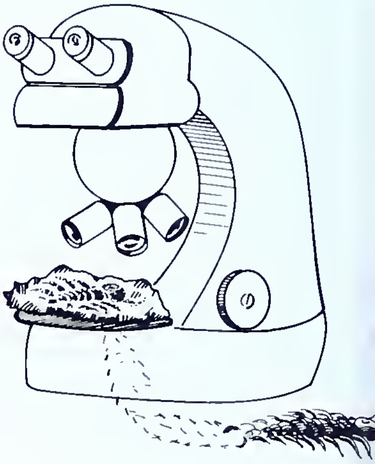
AUBREY CAMERON, Lehigh Univ. Fluid Inclusion Studies of Vein Minerals in the Jacksonburg Formation, Lehigh and Northampton Cos., Pa. ACD: Oct. 1977.

R. D. FINKELMAN, U. S. Geol. Survey, and **P. A. ESTEP-BARNES**, U. S. ERDA. Nickeloan Pyroaurite from the Cedar Hill Quarry, Lancaster Co., Pa. ACD: May 1977.

D. R. SIMPSON, Lehigh Univ. Dolomitization and Authigenic Minerals in the Beekmantown and Jacksonburg Formations [eastern Pa.]. ACD: 1979.

R. C. SMITH, II, M. L. ANNE, and others, Friends of Mineralogy. The Mineralogy of Pennsylvania, 1966-1975. Sixty species new to the state are described in detail with physical properties, chemistry, and precise location supplemented by crystal drawings, geologic maps, and mineral photographs. ACD: July 1977.

PALEONTOLOGY



T. M. BERG, Pa. Geol. Survey, and R. E. THOMS, Portland State Univ. Comparison of Burrows of the Devonian Bivalve *Archanodon* with Those of the Holocene Bivalve *Margaritifera,* and the Stratigraphic Implications of These Particular Trace Fossils. Burrows of *Archanodon* have been found at the base of the Catskill Formation in Pennsylvania from the Delaware Valley to Tioga Co., and in the Green Pond syncline of N. Y. and N. J. Laboratory analyses of burrowing behavior of *Margaritifera* have been continued to establish its validity as an analog to *Archanodon.* ACD: Early 1978.

P. A. DICKSON, H. B. ROLLINS, and J. D. DONAHUE, Univ. of Pitt. Paleontology and Paleoecology of Upper Carboniferous/Lower Permian Nonmarine Section in Pa., W. Va., and Ohio. Research has principally focused on the systematic description and distribution of nonmarine Bivalvia in the Appalachian coal field region. Emphasis is upon the stratigraphic utility and population dynamics of evolving populations in changing environments. ACD: 1977.

W. F. KLOSE II, Paleontological Research Inst. Curation of the Unger Collection of Fossil Plants and Insects, Reading Public Museum. Curation of Buck Mt. No. 5 specimens and fossil insects. Phase I, additional 7000 specimens. ACD: Phase I, 1978. Curation of the Everhart Museum Fossil Plant Collection, Scranton, Pa. ACD: Dec. 1977.

W. F. KLOSE II, Paleontological Research Inst. Cones and Megaspores of *Lepidocarpon* from Pa. [NE Pa.]. Materials for the study collected and curated. Review of specimens (types) at the USNM completed. ACD: 1977.

W. F. KLOSE II and DONALD BADMAN, Paleontological Research Inst.

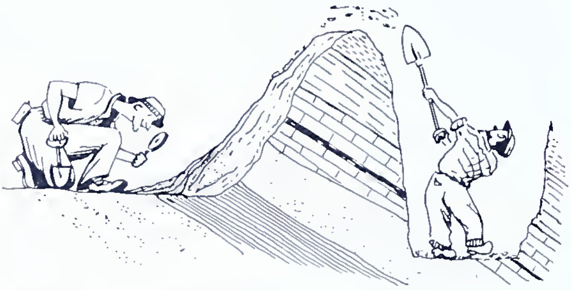
1. Additions to the Coal Fauna (Allegheny) of Pennsylvania [NE Pa.]. Specimens of crustaceans, insects, and medusa found in the past few years will be treated. ACD: 1978.
2. The Flora of the Baltimore Coal (Allegheny) [Wilkes-Barre]. ACD: 1979.
3. The Flora of the Clark Coal, Carbondale, Pa. ACD: 1977.
4. The Flora of the Sugarnotch 2 Vein. ACD: 1978.
5. The Flora and Fauna of the Buck Mountain 5 Coal [Southern Anthracite basin]. A study of fossil plants, insects, and crustacea from the Buck Mt. 5 coal (basal Allegheny Series) in the Southern Anthracite basin in the Klose, Badman, William Penn Memorial Museum, USNM, and Reading Public Museum (Unger Collection) collections. ACD: 1980.

JANICE MERRIAM and I. H. TESMER, SUNY at Buffalo, Canadaway Palynology of Erie County (Pa.), and Chautauqua and Cattaraugus Cos. (N.Y.). Field samples have been collected and processed and identification is underway. It is hoped that various horizons can be discovered and that a sequence can be established for correlation purposes. ACD: 1978.

H. W. PFEFFERKORN and M. S. SCHEIHING, Univ. of Pa. Variability in Species of *Alethopteris* from the lower Llewellyn Formation (Pennsylvanian) near St. Clair, Pa. The large number of specimens of *Alethopteris,* available from a bed of only 30 cm thickness, allows evaluation of the variability of the species present. The variability is greater and the number of species smaller than anticipated from reports in the literature. ACD: May 1978.

J. E. REPETSKI, M. E. TAYLOR, E. L. YOCHELSON and R. B. NEUMAN, U. S. Geol. Survey. Lower Paleozoic Stratigraphy and Paleontology of East-Central Pa. [chiefly Berks and Lehigh Cos.]. Project will study stratigraphy, bio-stratigraphy, and depositional environments of lower Paleozoic rocks in Hamburg Klippe and adjacent teranes. Work is in collaboration with A. A. Drake's project: Central Appalachian Tectonic History. ACD: Sept. 1981.

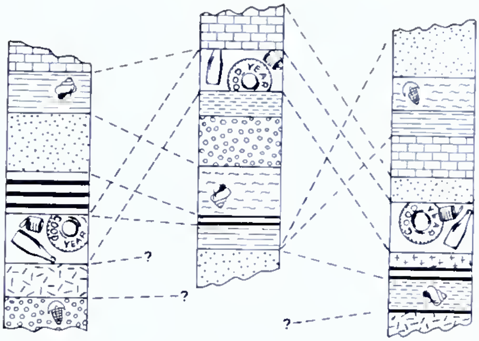
H. B. ROLLINS and J. D. DONAHUE, Univ. of Pitt. Trophic Analysis, Cyclicity, Evolutionary Rates of Conemaugh Communities [Appalachian Basin]. Reconstruction of Conemaugh marine communities with reconstruction of trophic structure. Study of evolutionary rates, inter- and intraspecific competition, character displacement, and competitive exclusion. ACD: Continuing.



SEDIMENTOLOGY

J. D. DONAHUE and J. M. ADOVASIO, Univ. of Pitt., and J. D. GUNN, Univ. of Texas at San Antonio, and ROBERT STUCKENRATH, Smithsonian Inst. Meadowcroft Rock Shelter [Avella, Washington Co.]. Excavation of paleo-indian site presently dated back to 16,000 B. P. by C-14 examination of sediments within colluvial pile at base of rock shelter. Attempt to reconstruct paleoclimate. ACD: 1978.

STRATIGRAPHY



PING-FAN CHEN, W. Va. Geol. Survey. Lower Paleozoic Stratigraphy of Central Appalachians. ACD: Completed.

J. M. DENNISON, Univ. of N. C. Purcell Member Marker Horizon and Its Correlated Carbonate Equivalents within Marcellus and Millboro Shales of Appalachian Basin Devonian.

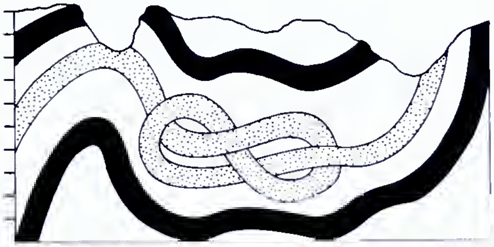
J. M. DENNISON and DANIEL TEXTORIS, Univ. of N. C. Summary of Tioga Bentonite Marker Horizon in Appalachian Basin Devonian Shale (U. S. ERDA contract). ACD: Late 1977.

W. E. EDMUNDS, Pa. Geol. Survey. Carboniferous of Pa. – Chapter in U. S. G. S. Professional Paper on Carboniferous of U. S. A 25-30 page summary of the stratigraphy, sedimentology, and economic geology of the Mississippian and Pennsylvanian of Pennsylvania. ACD: Fall 1977.

LOUIS HEYMAN, Pa. Geol. Survey. The Ridgeley Formation in the Subsurface of Pa. The subsurface Ridgeley Formation is defined by geophysical log markers. Delineation of the unit, a subsurface section showing lithic variations in the unit, and maps showing the extent and thickness of the unit and percent sandstone are planned. ACD: 1977-1978.

V. A. SCHMIDT, J. D. DONAHUE, and H. B. ROLLINS, Univ. of Pitt. Magnetostratigraphy of Carboniferous Sediments in the Appalachian Basin [SW Pa.]. Preliminary sampling and magnetic analysis within the Conemaugh Formation indicates that obtaining a complete reversal magnetostratigraphy of Carboniferous sediments in the Appalachian Basin is feasible. We have begun a comprehensive project with this goal.

STRUCTURAL GEOLOGY



J. M. DENNISON, Univ. of N. C. Effect of Late Precambrian Lineaments on Paleozoic Deposition and Subsequent Deformation of Appalachian Basin. Lineament in Pa. approximately along 40th parallel affected structural development and sedimentary tectonics in Late Precambrian, Ordovician, Permian, and Triassic. (Abstract of paper published in Geol. Soc. of America, Abstr. with Programs, v. 9, no. 3, p. 254-255.) ACD: 1978.

A. A. DRAKE, JR., PETER LYTTLE, MICHAEL TAYLOR, and J. E. REPETSKI, U. S. Geol. Survey. Central Appalachian Tectonic History [generally in area between Lehigh and Schuylkill Rivers]. A study of the evolution of the central Appalachians, particularly the role played by each of the major orogenies, their interrelations, and possible plate models. Structural studies will be supported by basin analysis and conodont studies. (Uncompleted work of Allentown quadrangle and vicinity project will be incorporated in this project.) ACD: Oct. 1981.

LOUIS HEYMAN, Pa. Geol. Survey. Subsurface Structure of the Plateau Region of North-Central and Western Pa. A map of subsurface structure on the top of the Ridgeley Formation, the base of the Mandata Shale, and the top of the Salina D unit, each where appropriate, is being compiled. ACD: 1978.

S. I. ROOT and D. M. HOSKINS, Pa. Geol. Survey. N 40° Latitude Fault System, Pa. ACD: 1977.

S. I. ROOT and D. B. MacLACHLAN, Pa. Geol. Survey. The Western Limit of Taconic Allochthons in Pa.

D. J. TEARPOCK and R. E. BISCHKE, Temple Univ. Structural Analysis of the Wissahickon Formation Along the Northern Section of the Wissahickon Creek Valley, Phila., Pa. This current research involving both the mesoscopic and microscopic analysis of the Wissahickon Formation reveals a complex polyphase deformational history consisting of three episodes of fold generation. This region appears quite similar to that seen in most thrust belts throughout the world. ACD: May 1977.

FIELD CONFERENCE IN NORTHERN NEW JERSEY

The annual Field Conference of Pennsylvania Geologists will examine Cambro-Ordovician stratigraphy and environmental geology of Northern New Jersey on October 6-8. New Jersey Department of Environmental Protection will serve as hosts and guides. Headquarters will be at Holiday Inn, East Stroudsburg, Pa. For anyone not on the conference mailing list, further details are available from Dr. Donald Hoskins, Pennsylvania Geological Survey.

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Continued from page 1

Always willing to serve, and interested in keeping abreast of current developments and new procedures, Bill has generously given of his time to serve on local, state and national committees, symposia, field trips, and short courses. He has served on committees of the American Association of Petroleum Geologists, the Interstate Oil Compact Commission, Ohio River Sanitary Commission, the American Petroleum Institute, the U. S. Bureau of Mines, the Southwestern Pennsylvania Oil and Gas Association, as well as officerships in the Northern Appalachian Geological Society, Pittsburgh Geological Soiety, and Middle District Oil Producers Association. Bill has had over 100 articles published in the major national oil and gas journals, and has presented well over twice that number of talks to professional societies in and out of state.

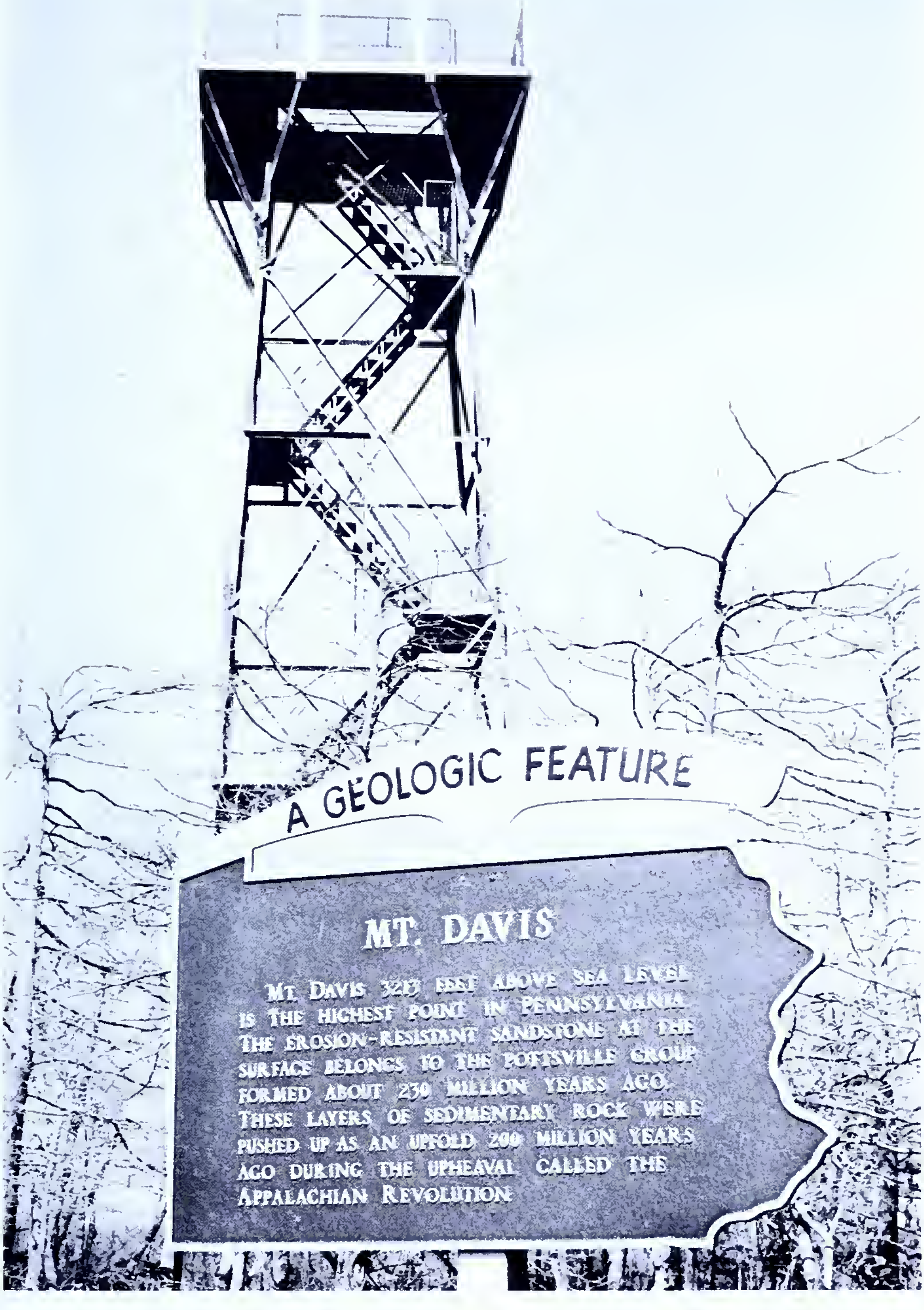
Bill Lytle's services to the public and the community have not been limited to his professional geological activities. He maintained his active status in the U. S. Army Reserves until his retirement from that service a few years ago as a full Colonel. He has been active in scouting in his home town of Butler, as well as helping to organize the National Scout Jamborees held in Pennsylvania. Bill has been an Elder in the Presbyterian Church since 1950 and has served the Butler Township School Board in a number of capacities.

Bill Lytle is a devoted family man. Married to Virginia Heath, a most charming lady and gifted writer and poet, they have four talented children, two sons in the arts, a meteorologist daughter, and a daughter college bound.

The Pennsylvania Geological Survey has been privileged to have Bill Lytle on its staff and the Commonwealth is the everlasting beneficiary of his outstanding services. To Bill Lytle, as a colleague and friend, we extend our deepest appreciation and heartiest wishes for a healthy and happy retirement.

Arthur A. Socolow

Mt. Davis (Somerset County) designed and authored by the Pennsylvania Geological Survey and erected by the Bureau of Parks. →


A GEOLOGIC FEATURE
MT. DAVIS
MT. DAVIS 3213 FEET ABOVE SEA LEVEL
IS THE HIGHEST POINT IN PENNSYLVANIA.
THE EROSION-RESISTANT SANDSTONE AT THE
SURFACE BELONGS TO THE POTTSVILLE GROUP
FORMED ABOUT 230 MILLION YEARS AGO.
THESE LAYERS OF SEDIMENTARY ROCK WERE
PUSHED UP AS AN UPFOLD 200 MILLION YEARS
AGO DURING THE UPHEAVAL CALLED THE
APPALACHIAN REVOLUTION.

Rare Fossils in Schuylkill County

by Alfred C. Palmer[1]

Schuylkill County has long been noted for its many exposures of the Middle Devonian Mahantango Formation. These sites have yielded extensive, varied assemblages of excellently preserved invertebrate fossils. The relatively new borrow pit reported here has one of the most varied assemblages and is especially noteworthy for containing rarities in Pennsylvania. The gastropod, **Buchanopsis leda** (Hall), has been reported found, well preserved, only once before in Pennsylvania (Ellison, 1965) and is fairly common here. The simple ammonoid, **Agoniatites vanuxemi** (Hall), is previously unreported.

The site is located on the west side of Pa. Route 61, 0.25 miles (0.4 km) north of the junction of Pa. Routes 61 and 895 in the village of Deer Lake (Figure 1). (Latitude 40° 37′ 19″ N, Longitude 76° 03′ 37″ W, Auburn 7 1/2 - minute Quad.) It is 0.2 miles (0.32 km) north of Locality 50 - Schuylkill County (Hoskins, 1969, p. 94). It is owned and operated as a source of non-specific-grade base material by George R. Lynn Inc. of Port Carbon, Pennsylvania. Mr. Lynn welcomes small numbers of collectors at any time that his heavy equipment is not operating in the pit, but assumes no liability for their safety. The company removes only about 10,000 cubic yards of material annually, so the site should afford excellent collecting for many years.

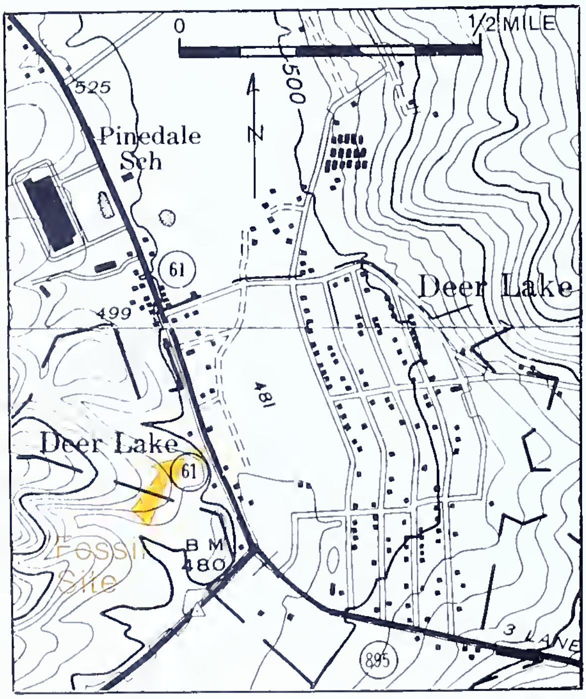


Fig. 1 Location of Schuylkill County rare fossils.

---

[1] Rose Tree Media School District, Media Pa. 19063

Fossils are distributed throughout the layers and lenses of gray, calcareous, silty shale characteristic of the Mahantango Formation in this area. Most specimens occur as internal molds and lack detail, but the more dense rock yields exquisitely preserved external detail and some original shell material. The best collecting at present seems to be toward the center of the western edge of the pit. It is here that gastropods and cephalopods are more numerous. A concentration of large pelecypods and brachiopods occurs in the southeastern portion of the pit. Small brachiopods, gastropods and trilobite fragments are concentrated together in pockets throughout the pit.

The fauna at the Lynn site, dominated by infaunal deposit feeders, is quite similar to that found nearby at the classic "Deer Lake" site (Hoskins, 1969). It is distinct in containing large numbers of gastropods and cephalopods. It is tempting to speculate that the Lynn site represents a shallow, lagoonal microhabitat along the Devonian shoreline, which was conducive to the quiet activities of mobile deposit feeders, moulting trilobites and their mutual predators. Quite possibly it might also represent a point of accumulation of pelagic debris.

On three collecting trips the author removed over one hundred fifty identifiable specimens. The forms identified and the number of examples of each are listed below:

BRACHIOPODS

"Chonetes"	10
Devonochonetes	3
Lingula ligea (Hall)	3
Mucrospirifer mucronatus (Conrad)	6
Orbiculoidea doria (Hall)	1
Protoleptostrophia perplana (Conrad)	3
Spinocyrtia granulosa (Conrad)	3
Tropodoleptus carinatus (Conrad)	6

PELECYPODS

Cypricardella bellastriata (Conrad)	2
Goniophora hamiltonensis (Hall)	2
Grammysia	2
Leiopteria	12
Modiomorpha concentrica (Conrad)	4
Nucula varicosa (Hall)	16
Nuculana diversa (Hall)	9
Nuculites triqueter (Conrad)	2
Orthonota undulata (Conrad)	6

GASTROPODS

Bembexia sulcomarginata (Conrad)	8
Buchanopsis leda (Hall) (Fig. 2)	8
Cyclonema	9
Tropododiscus	15
Unidentified bellerophontids (molds)	

CEPHALOPODS

Agoniatites vanuxemi (Hall) Fig. 3)	1
Michelinoceras	15
Unidentified ammonoids	4

TRILOBITES

Greenops (Greenops) boothi var. calliteles (Green)	1
Trimerus (Dipleura) dekayi (Green)	6

PLANTS

Fragments (Calamites)

Most of the specimens are illustrated in Ellison (1965) and Hoskins (1969). The individual specimens from which identifications were made have been donated to the Pennsylvania Geologic Survey and are available for study in the Paleontological Reference Collection.

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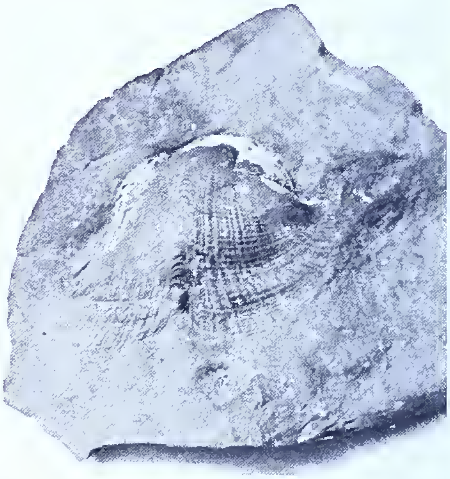
Fig. 2 **Buchanopsis leda** (Hall). Original specimen is 3.5 cm across. (Photo by Mariana Palmer)



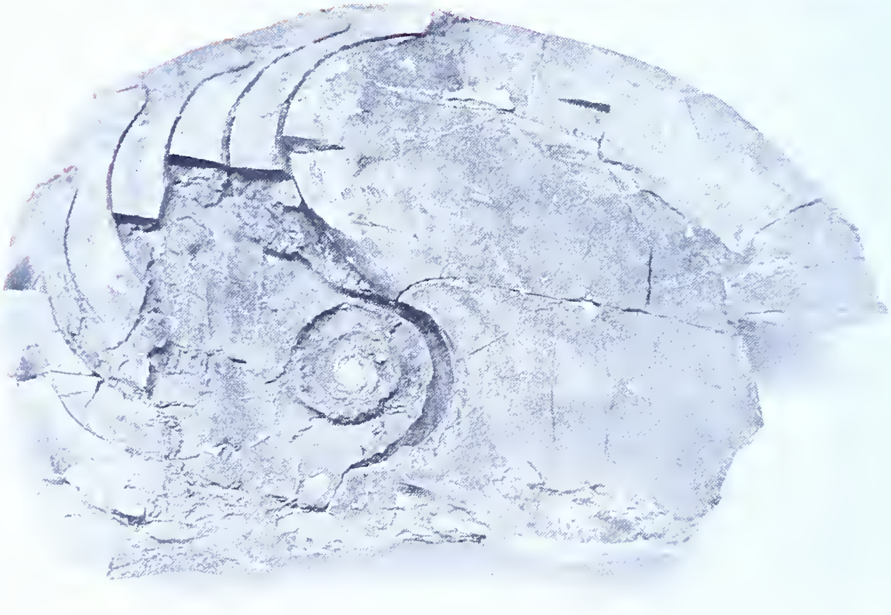
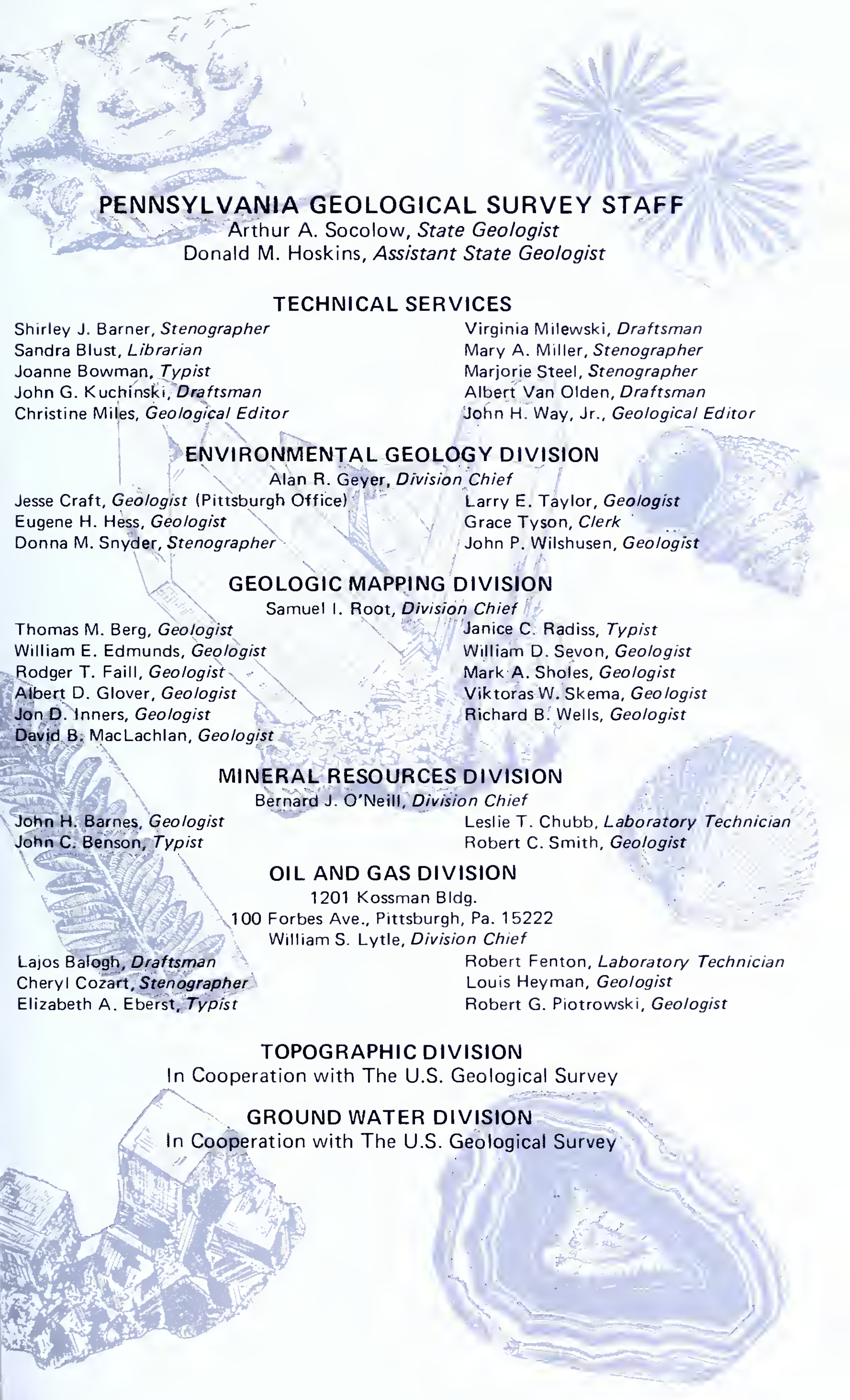


Fig. 3 **Agoniatites vanuxemi** (Hall). Original specimen is 15 cm at greatest diameter. (Photo by Mariana Palmer)



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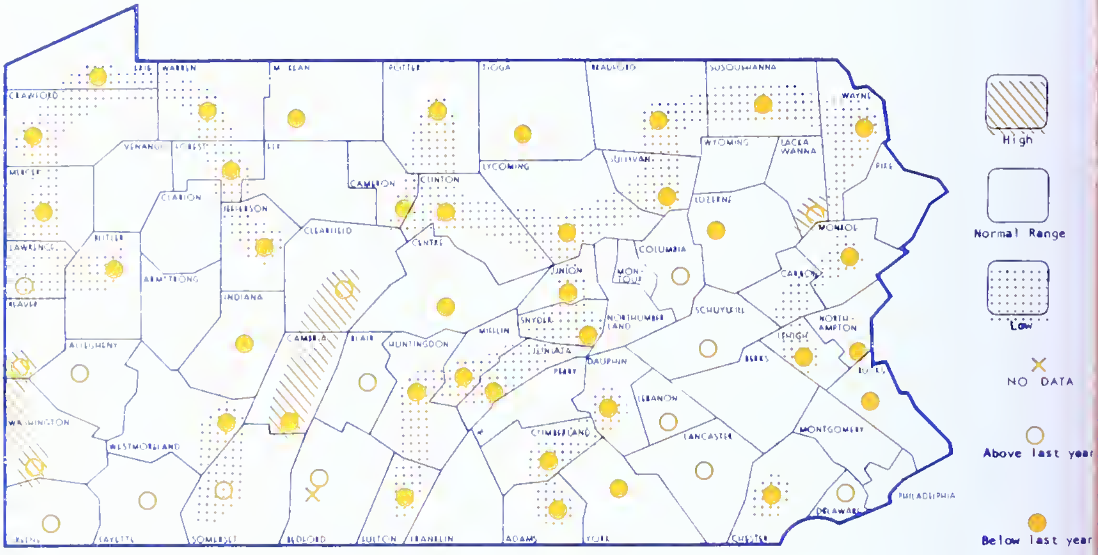

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ON THE COVER. The potholes at the Conewago Falls on the Susquehanna River were uncovered again this past summer. Their location is at the northwestern tip of Lancaster County where a Triassic diabase intrusive sheet crosses the river a mile below the Conewago Creek, near the village of Falmouth. *Photo by Wm. H. Bolles.*

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OCTOBER 1977

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

LEAD TIME - RHYMES WITH NEED TIME

In the discussions which have taken place amongst the proponents of various proposals to cope with our nation's energy problems, one aspect frequently tends to be overlooked, namely, lead time. That is the length of time that elapses from the time a decision is made to pursue a certain course of action, until the time when that action can be fully completed and implemented. Thus, for example, the lead time for bringing Alaskan oil into production was over 15 years from the time the decision was made in the early 1960's to explore and drill, then through 1968 when oil was first discovered on the North Slope, until 1977 when the first shipment for market was achieved. Similarly, even now as plans for an Alaskan gas pipeline to the U.S. are in the discussion stage, it will probably be close to 10 years from now before such a pipeline begins to deliver the natural gas.

While there is much talk of greatly expanding coal production, to develop a significant new coal mine from the point when a decision is made to do so until production actually starts generally involves between 5 to 10 years. First there is the need to locate an area of available coal. Then there is the time needed to raise the necessary money to acquire the land and purchase the mining equipment - commonly a matter of millions of dollars. Time is needed to design and engineer the mine layout and to construct the necessary equipment and machinery. Eventually, 5 to 10 years hence, comes the coal production. Even to expand an existing coal mine, is likely to require 3 to 5 years time.

The establishment of a power plant is another major lead time undertaking. A new coal burning plant is likely to take 5 to 8 years to bring into production from the time a decision is made to proceed. A nuclear power plant involves 8 to 12 years of time from the decision to go ahead.

The Alaskan oil production timetable is a good lesson as to what might be involved in the search for oil and gas off the Atlantic Coast. Even though oil companies made the decision several years ago to proceed with exploration, and having already invested several billions of dollars (without any real assurance that commercial quantities of oil and gas will actually be found), even under the best of possible discovery and development conditions in the Atlantic offshore, it will probably be close to 10 years before one or more offshore fields could be defined, financed, engineered, and the product brought ashore.

(Continued on page 16)

DR. JOHN MOSS

It is with profound sadness that we note the passing of a personal friend, a longtime friend of the Survey, and a distinguished scientist, Dr. John Hall Moss of Franklin and Marshall College. Dr. Moss died July 28th while doing geological field work at Phoenix, Arizona. He was mapping geological terraces in preparation for a paper he was to give this fall.

John Moss was very much more than a distinguished scientist. He was an outstanding teacher, a concerned and involved citizen, and a devoted family man. He did not simply teach students; he established a rapport with them, he excited them, and he stimulated them. He was an innovator of educational techniques and experiences and both he and his students were always abreast of the latest concepts and practices in matters pertaining to geology and the environment. It is a small wonder that under his leadership at the F & M Geology Department, so many of the geology majors have gone on to achieve distinguished careers in their own right.

John Moss was extremely interested in our Survey's programs. He recognized that there should be a close relationship between the role of the geologic educator and the role of a government geologist--both must be prepared to serve the public and the needs of our society.

John Moss recognized that geology is an active science that plays a vital role in today's society. He served on the Pennsylvania Environmental Council, the Pennsylvania Environmental Education Advisory Committee, the Geological Society of America's Committee on Environment and Public Policy, and the Lancaster Environmental Action Federation, to name just a few.

John Moss took his undergraduate education at Princeton University, his master's degree at Massachusetts Institute of Technology, and his doctorate at Harvard. He came to Franklin and Marshall College in 1948 and served as Chairman of the Geology Department from 1958 to 1971.

The Pennsylvania Geological Survey extends its sympathy and respects to Mrs. Margaret Moss and their six children.

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Pennsylvania State Geologist Heads National Association

Pennsylvania State Geologist, Arthur A. Socolow, has been elected President of the Association of American State Geologists at the 48th Annual Meeting of the Association, held at Rehoboth Beach, Delaware. The Association of American State Geologists consists of the Directors of each of the 50 State Geological Surveys and that of the Commonwealth of Puerto Rico. The Association serves to share and coordinate geologic policies and procedures, as well as to exchange the latest in geologic techniques. The aim is to effectively meet the geologic needs of the respective states and to cope with the geologic problems of the public and the nation.

Dr. Socolow previously served the Association as its Vice President, as Statistical Officer, and as Chairman of the Liaison Committee, designated to establish coordination of the activities of the state geological surveys with the programs of the various federal agencies involved with geological and mineral resource matters. The State Geologists Association has been effective in conveying local needs to federal agencies and expediting federal assistance and the development of federal programs.

Dr. Socolow joined the Bureau of Topographic and Geologic Survey in 1957 as Chief Economic Geologist, to conduct mineral resources investigations within the Commonwealth. In 1961 he was designated State Geologist and Director of the Bureau of Topographic and Geologic Survey. Dr. Socolow received his B.S. degree in geology from Rutgers University, and his M.A. and Ph.D. degrees from Columbia University. Prior to joining the Pennsylvania Geological Survey, he was a professor of geology at Boston University and at Southern Methodist University; during those years he was involved in mineral resources investigations in many parts of the United States, as well as Canada and Mexico. His background also includes service with the U. S. Geological Survey's Topographic and Geologic Divisions, including work in Alaska. During nearly four years of service in the U. S. Army Air Force, Dr. Socolow was engaged in photogrammetric mapping and air photo interpretation.

Dr. Socolow serves on many national and state committees and task forces, both as a representative of the Commonwealth, and as a member and officer of numerous national geological societies.

Living with our Stone Industry

by Joan J. Sevon

We, the citizenry, and our Pennsylvania stone industry are frequently at loggerheads over quarrying. How much better to live in mutual agreement than to battle one another! I propose that this mutual agreement is possible, but it takes understanding. Understanding on our part includes knowledge of the stone industry's employment potential and economic support to our community, the everyday essential uses of stone, the reasons for quarry location, and the industry's environmental plans. Understanding on the stone industry's part includes dealing with air, water, and noise pollution, and the general eyesore its operations create for those living near a quarry or along a hauling route. Together we can build a satisfying environment in which to live.

The stone industry is one of our major industries. It employs an estimated 6,000 persons in Pennsylvania. Preliminary data from the United States Bureau of Mines show that the value last year of our basic aggregate production was $196.3 million and that we ranked fifth nationwide in production. Limestone dominates these figures. The largest use of crushed limestone in Pennsylvania is for dense-graded road-base stone, followed by stone for Portland cement, and stone labeled "other construction aggregate and roadstone." Production of crushed limestone and dolomite is also important in our commonwealth for use as agricultural lime.

These are major uses of limestone and are important to us. For example, the Pennsylvania Department of Transportation (PennDOT) used approximately 1.2 million tons of plain aggregate, plus the aggregate in 2.1 million tons of other asphalt road material, for just maintenance last year, and every building in our capitol complex is made of either stone or concrete. The importance of agricultural lime is well documented. Studies by The Pennsylvania State University show higher crop yields following applications of lime on acid soils, a vital concern for us in this day of increasing food demand.

Some of the other uses of limestone may not be quite as familiar as these major ones, but they are just as important to us because we use them every day. For example, limestone is used in paper, glass, paint and varnish, soap and detergents, textiles, refractories, baking powder, milk of magnesia, bicarbonate of soda, and toothpaste. It is finely ground and used to control coal-mine dust and to purify power-plant exhaust gases of sulfer dioxide. The new power plant at Shippingport, Pennsylvania, is estimated to need 6,000 tons of limestone per day for this latter purpose alone, and limestone is also used in other purification processes, such as water and sewage treatment and acid-waste neutralization. An old and important use of limestone and dolomite is for flux in making steel; about one-half ton of limestone is used to make one ton of steel.

These are truly a great many uses for limestone; we would seriously miss our quarries if they should go out of business. The problem is for us to live with the necessary quarrying operations. The stone industry is a very localized business operation; the quarry *must* be close to its market, usually an urban center, to remain economically viable and, therefore, in business. The unit price of stone is very low, the lowest of any mineral mined in Pennsylvania. The price varies from $2.00 to $3.00 per ton, depending on the type of stone, its use, and the need for crushing. An operator must do a large volume of business to make a profit. This makes transportation costs and distances critical to his business. The difference between trucking stone five miles and 20 miles at $0.13 per ton mile (PennDOT's established hauling figure) means a difference in cost of $1,950,000 for a million tons. At only $2.00 to $3.00 per ton, increasing distances from source to user quickly become uneconomical.

The other critical factor for a quarry's location, of course, is geology: a company can only mine limestone where the limestone occurs. We must, therefore, guard against zoning our stone industry out of business. The danger is that we will force the industry out of its economic transportation range and prematurely build over the mineable site, completely losing the stone resource.

Our Pennsylvania stone industry is increasingly correcting air, water, and noise pollution and the general appearance of its operations. Almost all quarry operators now cover conveyor belts and practice wet stone crushing or use suppressant sprays to keep down the dust. Some enclose crushers to insulate against noise, and many operators construct berms, fences, and plantings to make quarries easier on the eye and safer for visitors or trespassers.

All currently active quarries now comply with our Pennsylvania regulations which require a reclamation plan for eventually mined-out properties. The minimum requirement is to reduce any steep slope to 35° or less and to backfill and reseed disturbed areas. Many of our Pennsylvania operators, however, are going far beyond the minimum. For example, a reclamation plan drawn up in 1967 for a large Hummelstown quarry is already being implemented while the

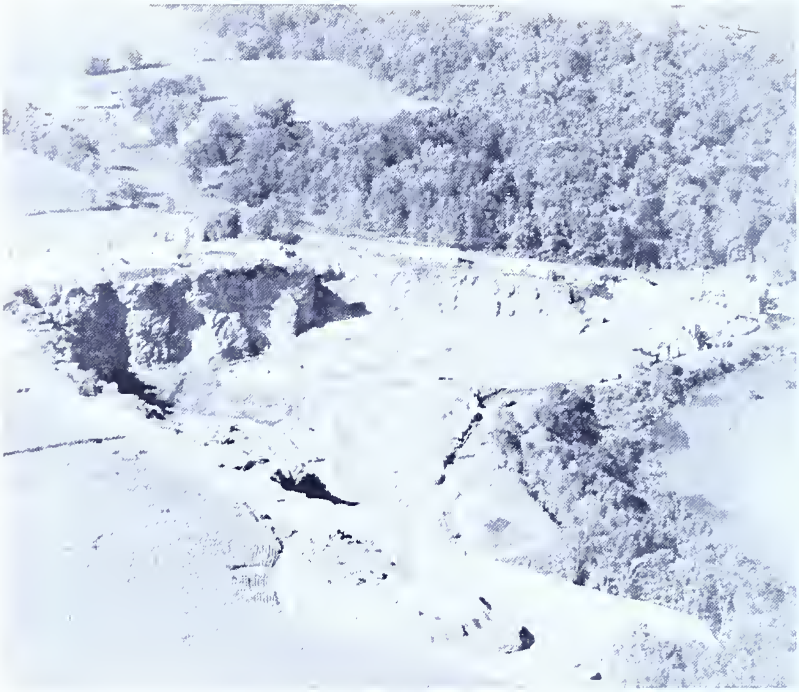

Fig. 1 A Lancaster County quarry as it looks today.

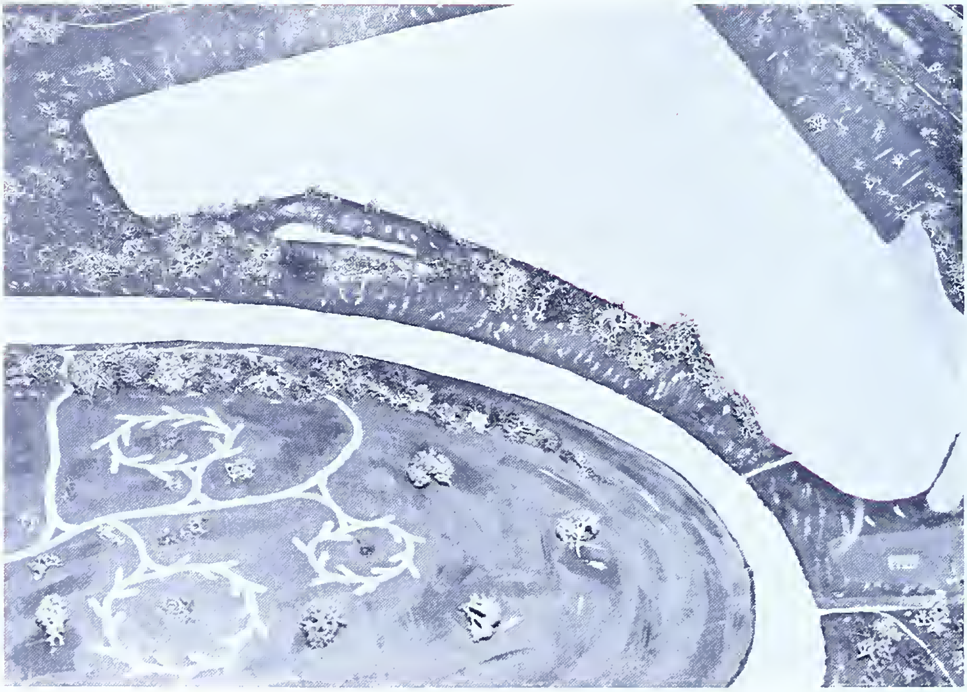

Fig. 2 A model of the reclamation plan for the above Lancaster County quarry, showing the area when the 38-acre park and 50-acre lake is completed.

quarry is still operating. Stripped overburden is dumped where it will eventually be used in the construction of a 19 hole golf course and a residential community.

An elaborate reclamation plan has been worked out for a Lancaster Township quarry. After mining is complete, they plan to make a 50-acre lake and landscape 38 acres around it for a park which they propose to give to the township (Figures 1 and 2). The company also proposes to put money aside every year in an escrow account for maintenance of the park. Their quarry is in a highly populated area; a park would be a great addition to the Township's facilities.

The rub is that many of our townships are rezoning quarry property and discontinuing nonconforming use which keeps some companies from mining their reserves - and we, the citizens of Pennsylvania, from using their product. Here is an excellent example of the need for understanding compromise. Our stone industry shows it can live peacefully with its neighbors by covering conveyor belts and crushing stone wet or using suppressant sprays (not to pollute the air with dust), keeping its used water in a closed system (not to pollute surface or ground water), blasting with only a few holes and double delay (not to shake nearby houses), and in some instances, giving the neighborhood a park.

What will *we* do? Will we understand that our Pennsylvania Stone Industry is mining a resource we *need*? Will we let them continue to mine? Will we continue to benefit from the many uses of their product and ultimately enjoy their parks? The choice is ours, but a wrong choice could drastically affect our life style.

A GUIDE FOR SOUTHWESTERN PENNSYLVANIANS

The Pittsburgh Geological Society has issued a book entitled *"Lots of Danger -- A Property Buyers Guide to Land Hazards in Southwestern Pennsylvania."* The illustrated 85-page book identifies and describes the various types of geologic conditions and hazards which affect construction in southwestern Pennsylvania. They include landslides, subsidence over mined-out areas, and flood plains.

"Lots of Danger" may be purchased for $3.85 from Pittsburgh Geological Society, P.O. Box 3432, Pittsburgh, Pa. 15230.

Pennsylvania Iron: Foundation of the American Revolution

by Charles H. Shultz, Professor of Geology
Slippery Rock State College

The role played by geology in the conduct of the American Revolutionary War is generally not appreciated by laymen or geologists. One of the more important aspects of this role is the occurrence of iron ore deposits that were hidden in the forested wilderness of colonial southeastern Pennsylvania. It is probably fair to state that the Revolutionary War occurred by the consent of Pennsylvania geology. That is not to say that the war would not have taken place without Pennsylvania's resources, but rather that the character of the conflict would have differed markedly and may have taken much longer without the cannon, shot, and other material supplied by Pennsylvania ironmasters.

The importance of Pennsylvania iron ore deposits was not early recognized. In fact, Pennsylvania was about the last colony to begin the manufacture of iron. The first iron-making in the new world probably occurred near Jamestown, Virginia in 1608 and there was a vigorous industry around Lynn and Saugus, Massachusetts in the mid-1600's. The first iron works in Pennsylvania was Poole Forge in Berks County, established by Thomas Rutter in 1716. This rather primitive facility was a bloomery forge, very similar to the hearths used by blacksmiths. The first charcoal blast furnace, which was the principal technology used in the manufacture of iron at the time of the Revolutionary War, was Colebrookdale furnace founded in 1720 near Boyertown. From this small and rather tardy beginning the manufacture of iron blossomed in Pennsylvania to become the foundation stone in the production of the means of war at our country's birth.

What were the requisites for the making of iron using the charcoal blast furnace? Abundant forests for the manufacture of charcoal and rapidly flowing streams to power the water wheels that created the air blasts for the furnaces were very important. So were capital and human resources, such as skilled labor possessing know-how and determination. But there were two indispensible ingredients: iron ore and limestone (that serves as a flux) with which Pennsylvania was well endowed.

There are three principal types of iron-ore deposits in the southeastern part of this state. These are residual limonite and hematite deposits, magnetite-bearing Precambrian gneisses of the Reading Prong, and Cornwall-type contact-metasomatic magnetite deposits. Of these, the Cornwall-type deposits were clearly the most important during the Revolutionary War. They are associated with Triassic diabase intrusions that produced iron-rich solutions as the diabase crystallized. These chemical solutions partially replaced chemically favorable adjacent rocks, primarily limestone, with a mixture of magnetite, pyrite, chalcopyrite, and numerous other minerals. The type-locality for these deposits is the famous Cornwall mine in southern Lebanon County (then part of Lancaster County) discovered in 1732 by Peter Grubb. Besides Cornwall itself, similar ore deposits that were utilized during the Revolutionary War and that are still recognizable, are the Hopewell Mines and the Jones "Good Luck" Mine in Berks County, and the Warwick Mine in Chester County. There were undoubtedly many other active mines during the war and many that were opened in the years following the war. The only currently active mine on Cornwall-type ore deposits is the Grace Mine at Morgantown. This deposit was completely unknown to 18th century miners, however, since its closest approach to the surface is about 1500 feet below ground level and was discovered only about 20 years ago. All iron mining during the Revolutionary War was of the open-pit type on ore deposits exposed at the surface, although some minor experimentation had taken place with underground mining.

Most blast furnaces in colonial Pennsylvania were built in remote wilderness areas associated with self-sufficient villages or plantations that reportedly resembled benevolent feudal manors of medieval Europe. Besides the manufacture of iron, farming, spinning, weaving, candlemaking, wagon making, and food preservation were among the important activities in these isolated villages. Hopewell Village, which is now a National Historic Site, is the only surviving example of the 16 blast-furnace plantations believed to have been in operation in Pennsylvania during the Revolutionary War. Hopewell was founded in 1770 by Mark Bird and has been restored by the Federal government to its condition of the period of 1820 to 1840, a time of great prosperity for the furnace. Thousands of visitors tour the facility each year and during the summer months one may observe individuals in period dress performing tasks similar to those of long ago.

It required about 5,000 to 10,000 acres of forest to support a blast furnace. One acre of forest produced about 21 to 24 cords of wood, which yielded the charcoal necessary to make one ton of pig iron. More than 6,000 cords of wood were consumed by a typical furnace each year, requiring a large number of wood cutters and colliers (charcoal makers). In contrast, two or three miners could supply a single blast furnace from open pits with all the iron ore and limestone needed. About two tons of ore were required to make one ton of pig iron, which required 12 hours to make. Most of the iron was poured into molds to make stove plates, hollowware, cannon, and shot. Some was poured into ingots called "pigs" and turned into wrought iron for tools and swords in forges at the furnaces or nearby.

Of the furnaces that made cannon, shot and other tools of war, only a few remain and none of the forges have survived. Besides Hopewell, Cornwall Furnace at Cornwall in Lebanon County is well preserved and is open to visitors under the auspices of the Pennsylvania Historical and Museum Commission. Some of the other surviving relicts of the Revolutionary War iron industry include Durham Furnace and mines in northern Bucks County, Hopewell Forge

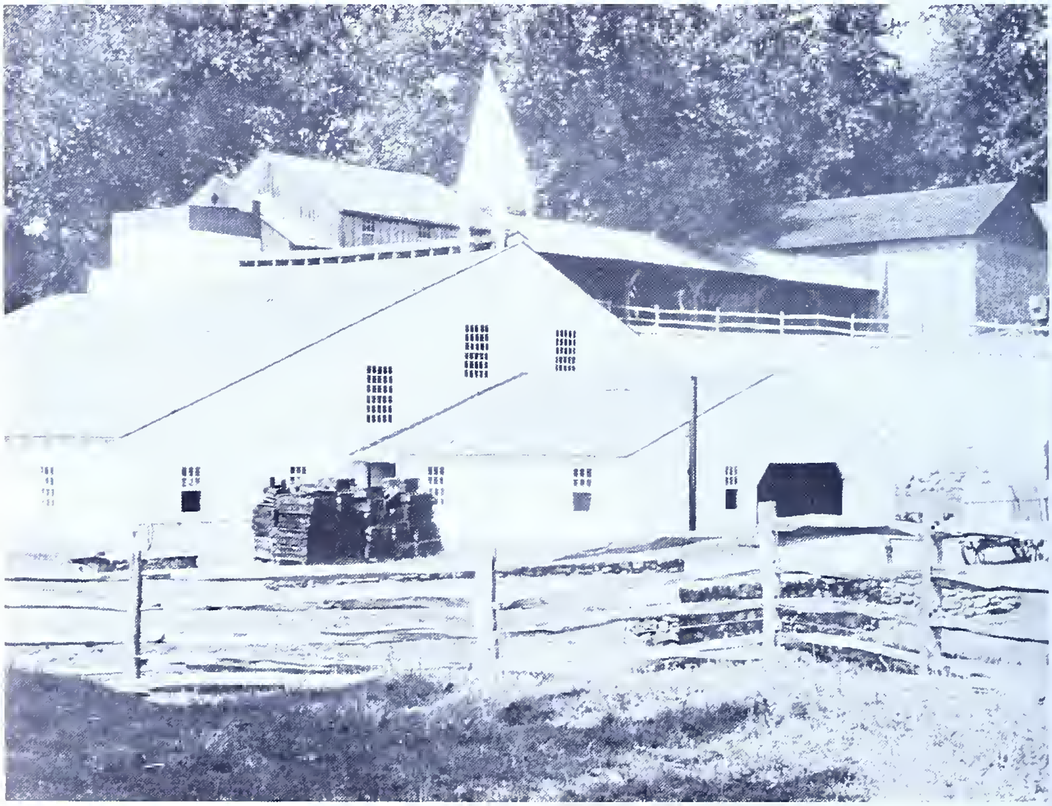

Fig. 1 Overview of Hopewell Furnace showing the casting house, furnace, connecting shed and charcoal house.

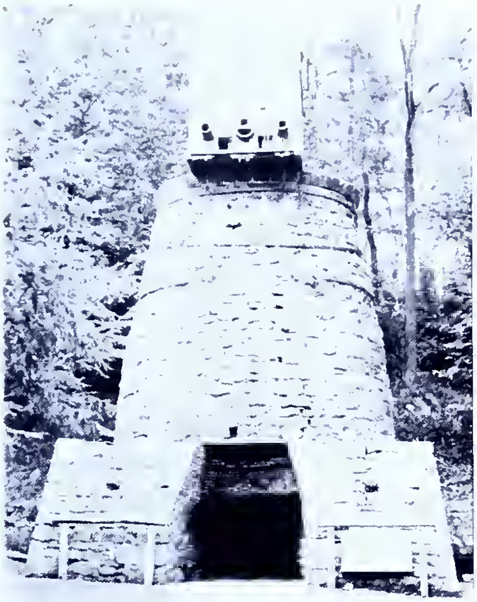

Fig. 2 Remnants of Codorus in York County.

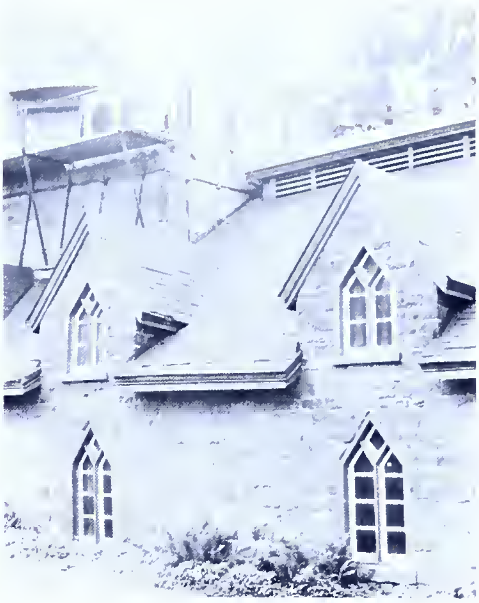

Fig. 3 Casting house and furnace at Cornwall.

mansion in Lancaster County, Pottsgrove mansion in Pottstown, Codorus Furnace in York County, Martic Forge mansion in Lancaster County, and Oley Furnace and Joanna Furnace in Berks County. Most of the mines, furnaces, and forges exist only in history books or as obscure slag and gob heaps beneath forest litter.

Since Pennsylvania was not alone among the colonies in possessing significant iron-ore deposits, forests, and water resources, why does it stand out as a keystone in the war effort? One explanation lies in the character of early European immigrants into southeastern Pennsylvania, especially the Welsh, English, and Germans. Among those people were individuals who possessed a knowledge of iron making and who either had sufficient capital to start a furnace or enough business sense, perseverence, and determination to promote support. Once the resources were recognized, the industry developed rapidly. The ironmasters were an independent lot and were particularly angered by the British Iron Act of 1750. This law was typical of the restrictive and repressive measure taken against the colonists by the British and should rank with the Tea Tax Act as one of the principal causes of the move toward independence. The iron act sought to guarantee a source of pig iron for British manufacturers and to prevent colonists from developing the skill and where-with-all to make articles out of iron such as nails, stoves, and cannon. For numerous reasons, in Pennsylvania the thrust of the law was a total failure, not the least of which was the remoteness of the iron industry. This isolation allowed the Pennsylvania iron industry to develop in freedom without interference or harrassment by British officials or troops.

Unfortunately for the British, the principal consequence of the Iron Act was to alienate the ironmasters who, to a man, worked vigorously for the cause of independence. The involvement included direct military service, politics, and the manufacture of weapons for Washington's army. During the war labor was in short supply and the iron industry was so important to the war effort that deferments to military service were enforced on Pennsylvania iron workers. The extent and diversity of the involvement of Pennsylvania ironmasters and their industry can only be aluded to here, but a few examples will suffice:

—George Ross was a signer of the Declaration of Independence,

—John Potts was a member of the State Constitutional Convention of 1776.

—Issac Potts, his son, was the owner of Valley Forge, which was burned by the British two months before the encampment of the continental army, and his house served as Washington's headquarters in the bitter winter of 1777.

—Mark Bird was the commander of the 2nd Battalion of the Berks County Militia and led into battle 300 men, which he provided with arms, uniforms, food, tents, and so forth at his own expense.

—Washington crossed the Delaware to the Battle of Trenton on December 26, 1776 in freight boats built at Durham Furnace to haul iron products to Philadelphia.

—It is reported that cannon cast at Cornwall possessed a greater range than those used by Cornwallis at the Battle of Yorktown, thus significantly speeding the defeat of the last British army.

One is compelled to agree with Arthur Cecil Binning (1938) who said that if the iron industry in Pennsylvania had not reached such a high stage of development, the colonists would have been helpless in the revolutionary war conflict. Of course, geology was the foundation of that industry.

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PLENTY of FOREWARNING

"I conceive that it is totally unnecessary for me to make any comment upon the great advantage it would be to this country to be supplied with all the useful metals from its own mines; to purchase which, an immense sum, everyone knows, is annually sent to Europe."

The above statement appears to be very timely, in view of a growing national concern over the U. S. imbalance of foreign payments related to growing U. S. dependence on foreign sources for minerals and oil.

It is ironic that the above quotation was written in 1797 by Benjamin Renfrew as the opening statement in his Preface to *A Plan With Proposals for Forming a Company to Work Mines in the United States.* Renfrew went on to state:

"Americans are an enlightened people and very capable of judging of what is calculated to promote the true interest of their country."

"The greatest difficulty, that I see will attend it, is, that mining is a business, that people in general are afraid of being concerned in."

We certainly cannot say that we were not forwarned! Benjamin Renfrew aptly described our present situation 180 years ago!

STATE MAP COMPILATION – OPEN FILE

The Pennsylvania Geological Survey is placing on open file the completed compilation sheets prepared for the new state geologic map. The majority of these compilations are hand drawn on 1:24,000 quadrangle sheets. A portion of northwestern Pennsylvania was revised at 1:62,500 scale; there are twenty-four such quadrangles.

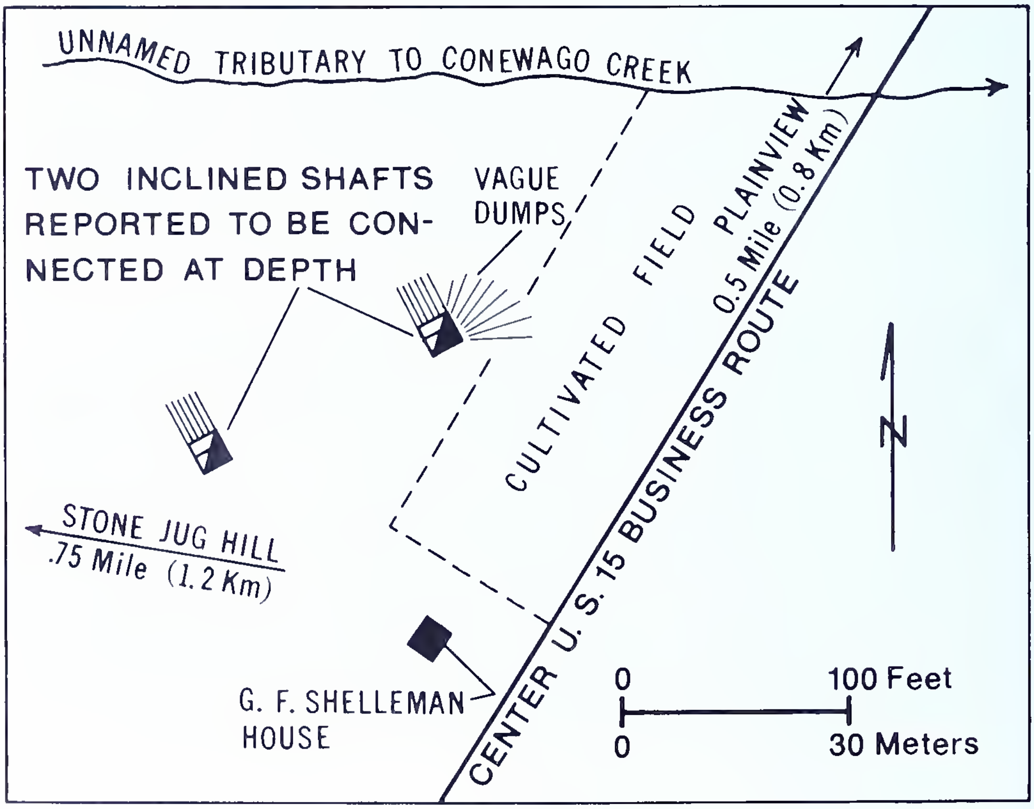
These new maps may be examined only in the library of the Harrisburg office of the Pennsylvania Geological Survey, Executive House, 101 S. Second Street, Harrisburg, Pennsylvania 17101. Questions regarding the maps should be directed to Thomas M. Berg, who is in charge of the new state map project.

Newly Discovered Minerals At Stone Jug Copper Prospect, Adams County

by Robert C. Smith, II and Donald T. Hoff

Re-examination of the Stone Jug copper prospect shows it to be of geologic and mineralogic interest, and perhaps a clue to economic mineralization. Recovery of several specimens of molybdenite by Lloyd Shelleman, the owner's son, prompted our re-examination.

When visited, numerous small mineralized chips were found in a field east of two water-filled, inclined shafts reported to be connected at depth (G. F. Shelleman, personal communication, 4/10/76). Unlike Stose (1932, p. 139), who found only rock discolored by copper carbonate but no copper ore, the authors found common bornite as well as malachite with minor to trace amounts of chalcocite, djurleite (the second reported locality in Pennsylvania), chalcopyrite, molybdenite, powellite (also second reported locality in Pennsylvania), azurite, and chrysocolla. Analyses of a ten-pound bulk sample of small chips selected to show at least a speck of malachite showed the presence of 6.0% Cu, 2.97 oz Ag/ton, 0.048 oz Au/ton, and 180 ppm Mo. At present (low) prices, this would



be $70.00 per ton for copper, $13 for silver, and $7.00 for gold for an impressive total of $90.00 per ton. However, this represents a somewhat high-graded sample and the ore zone may have been only a few inches thick. For Pennsylvania, the calculated gold content of about 0.5 oz/ton (and 30 oz Ag/ton) in a bornite concentrate containing 60% Cu is still impressive because of the general rarity of gold in the state.

Two exploratory holes are reported to have been drilled approximately 200 yards north of the northern shaft in 1955 or 56. In 1959 (?), four or five additional test holes were drilled about 1/2 mile (0.8 km) southeast of the prospect. The exploration companies did not release logs of the cores (L. Shelleman, personal communication, 3/1/77).

The area of the prospect was mapped by Stose (1932) as a Triassic hornfels, and indeed the ore seems to be localized in baked calcareous sandstone within dark shale. The gangue minerals, andradite-grossular, epidote, heulandite, hornblende (?), schorl, and stilbite, also suggest a hornfels. The source of heat for the baking, and perhaps also the source of the metals, was intrusion of Triassic diabase magma to the west. This is evidenced by Stone Jug Hill, a diabase intrusion rising 120 feet (37 meters) above the surrounding area.

Stone Jug Hill, with a 1280 gamma aeromagnetic anomaly above the regional background, was noted by Bromery and Griscom (1967) as being favorable for a magnetic body within 1500 feet (460m) of the surface. Stone Jug Hill was drilled for magnetite in 1950 by the Bethlehem Steel Corporation. Cores from three test holes suggested that the local magnetic high might be caused by accessory magnetite in the diabase and granophyre (a pinkish, coarse-grained diabase differentiate). Appreciable magnetite replacement of the sediments lying immediately above the intrusion, a favorable place for Cornwall-type iron-copper ore bodies, was lacking in the area tested. The observed sulfide mineralization was limited to local pyrite in granophyre fracture fillings and disseminations. None of the core material was assayed for Cu, Ag, Au, or Mo (S. J. Sims, Bethlehem Steel Corp., personal communication, 2/10/77). Because the copper occurrence has unusual amounts of Ag, Au, and Mo, limited geochemical and geophysical exploration in the Stone Jug intrusion area may be warranted. A second diabase sheet with its own contact metamorphic zone may exist at depth, similar to the situation at Dillsburg, 16 miles (25 km) to the northeast (Smith, 1975, p. 948 and Hotz, 1950).

Sheely (1886) notes that a Stone Jug copper mine, opened about 1845, is located seven miles from Gettysburg on the Harrisburg-Gettysburg road. A Maj. Robert Bell was responsible for hauling the first load of ore, weighing three tons gross, to Baltimore in 1846. Sheely makes the dubious statement that the mine was ". . .worked actively for several years, during which time large quantities of good ore were taken out and sold, . . ." Shortly after 1846, the miners were transferred to certain of the Lake Superior district copper mines managed by the same company. Operations were resumed several times at the Stone Jug mine during the latter half of the 19th Century, with stockholders of the different auspices suffering financial embarrassment. "Old timers" have reported [additional] copper prospects about 3/4 mile northwest and ¼ to ½ mile southeast of the Shelleman prospect.

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(FROM THE DESK Continued)

The point to this discussion is simply that there are no quick solutions to drastically improve the nation's energy self-sufficiency. Particular caution is directed to those who hope for major new energy sources via techniques which have either not yet been invented, or scientifically resolved, designed, or engineered. Thus, any really major energy contributions from wind, geothermal, tidal, space stations, fusion, or even solar techniques are likely to involve a lead time of 20 to 25 years. They all should be considered and pursued, but let us not delude ourselves on the delivery time.

Arthur A. Socolow

PENNSYLVANIA GEOLOGICAL SURVEY STAFF

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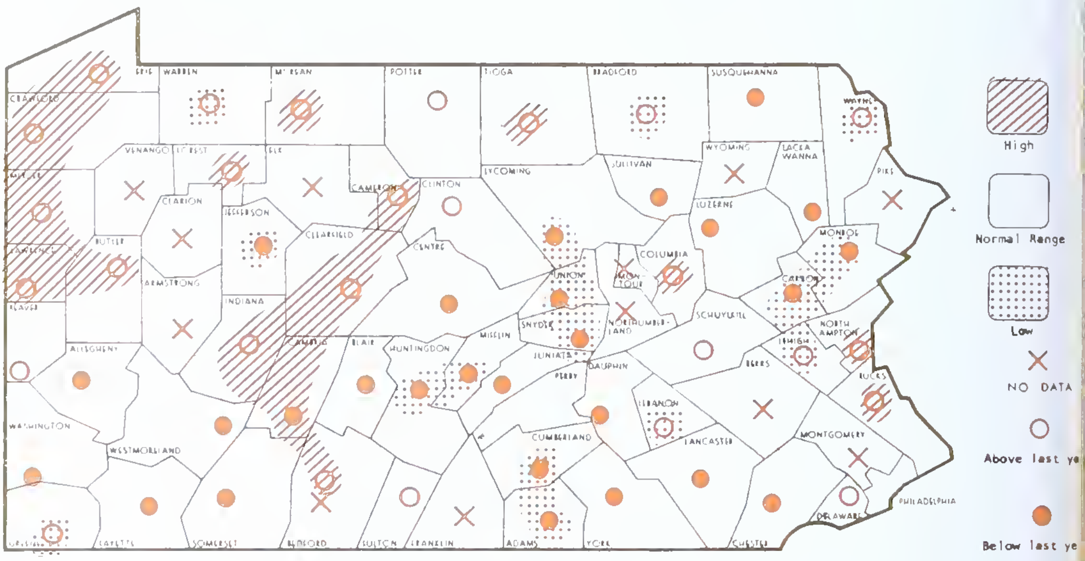

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Vol. 8

COMMONWEALTH OF PENNSYLVANIA
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TOPOGRAPHIC AND GEOLOGICAL SURVEY
Arthur A. Socolow, State Geologist

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ON THE COVER: Catastrophic results of landsliding in Allegheny County. Note collapsing foundation in lower right foreground; this house has since had to be demolished. Home in upper part of photo shows exposed basement and ruined patio due to sliding of side yard and back of lot. Area between these two houses once was occupied by two additional homes destroyed by slide. *Photo courtesy of Dr. Jesse L. Craft.*

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DECEMBER 1977

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

MINERAL ECONOMICS
A TALE OF TWO COMMODITIES

It is commonly believed that "harvesting" the mineral wealth of an area is simply a function of discovering the resource and then proceeding to extract it from the ground. Two recent Pennsylvania developments point up the primary role which basic economics plays in the success or failure of locating and utilizing the mineral resources with which we were endowed.

At Morgantown, Pennsylvania, one of the nation's most modern underground iron mines, the Grace Mine, has closed down, even though the reserves of this major orebody are large and the grade of the ore is high. But the effect of foreign steel imports and the availabliity of low cost, high grade, foreign iron ore to supply the remaining domestic steel furnaces has created an economic situation with which the Pennsylvania iron mine could not compete.

Mineral economics, however, can work both ways. As the need for natural gas has increased, so has the price. First came the price increase for unregulated, intra-state gas (produced and consumed within the state), and then the slow, step-by-step increase of regulated, interstate gas prices. The result in Pennsylvania has been a markedly increased program of exploration and drilling for gas, both by established gas-producing utilities, as well as by small industries seeking only to obtain their own gas needs. The higher natural gas prices made it worthwhile to drill deeper than before, and in places where the risks were greater. The result of this favorable economic climate has been a string of impressive new gas discoveries in Pennsylvania involving many areas, including Somerset, Centre, and Lycoming Counties. More discoveries are likely as the drilling pace continues.

Geologists play a vital role in developing our vital mineral resources. We can "point" to where the geologic conditions indicate the likelihood of finding various additional mineral concentrations. It is economics, however, that in the final analysis determines whether the mineral resource will be developed. The examples above demonstrate that economic conditions do not remain static; for any particular commodity they may improve or worsen. Geologists, such as the Pennsylvania Geological Survey, have an obligation to identify and inventory the mineral resources with which we have been blessed, so that when the economic conditions become favorable, rapid strides can be made to utilize those resources to serve the needs of our society.

Arthur A. Socolow

The Meadowcroft Rockshelter

The Earliest Evidence of Stoneage Man in North America

by William H. Bolles
Dept. of Education

Standing under a massive sandstone overhang on a ledge some 50 feet above Cross Creek it taxes the imagination to go back some 16,000 years and visualize the rockshelter being occupied by the Paleo-Indians, the most ancient man known to the new world and the contemporaries of the Cro-Magnons who decorated the walls of their caves in northern Spain with paintings of bisons.

The Meadowcroft Rockshelter is located about 2.5 miles northwest of the town of Avella in Washington County on the north bank of Cross Creek, a small tributary of the Ohio River which lies 7.5 miles to the west. The exact location of the site is 40° 17′ 12″ N, 80° 29′ 0″ W (USGS Avella, Pennsylvania 7.5′ Quadrangle).

A view of the Meadowcroft Rockshelter's eastern overhang. The exposed rock is the Morgantown-Connellsville sandstone, a massive fluvial or channel sandstone of the Casselman Formation of the Pennsylvanian Period. The site has been roofed over to keep it dry while the excavation is in progress.

Underneath the roof over the excavation, students from Pitt carry out the painstaking job of digging, locating and marking each artifact, bone and seed. Carrying out this process through a cubic meter of strata can take two persons an entire summer to complete.

Geologically, Meadowcroft is located in the Pittsburgh Plateaus Section of the Appalachian Plateaus Province. The surface rocks of the area are those of the Casselman Formation of Middle to Upper Pennsylvanian Age. The dominant lithologies are shale, sandstone, limestone, and coal in decreasing order of abundance. Topographically the region is a maturely dissected plateau with more than 50% of the area in valley slopes with upland and valley bottom areas in the minority. Since the Wisconsin Glacial boundary in northern Beaver County is about 25 miles to the north, the present topography was most likely developed during the Pleistocene when increased precipitation and runoff caused extensive downcutting. The Meadowcroft Rockshelter and the Cross Creek Valley probably existed in almost their present configuration well before the close of the Wisconsin Glacial Period, ca. 11,000 B.P.

The excavation at the Meadowcroft site has been going on for the past five summers under the direction of Dr. James M. Adovasio, Assistant Professor of Anthropology at the University of Pittsburgh.

At the end of this field season, the rockshelter will be closed for at least a decade. The materials already taken from the site will keep laboratory analysts busy for many years and the undisturbed deposits, about 35 percent of the original, will remain ready for use when new methods of recovery and analysis are developed.

The Meadowcroft Rockshelter represents not only the oldest dated site in North America but also one of the longest occupied stratified sequences in the northern hemisphere of the New World. The Paleo-Indians who first occupied the rockshelter possessed a relatively sophisticated lithic technology which included the production of prismatic blades, unifacial blades, bifaces and delicately flaked "knives". They were most probably attracted to the site by the same factors which make it attractive at present. These are readily available water, protection from the elements, and abundant edible flora and fauna. Meadowcroft was a station for hunting, collecting, and food processing activities; a stopping-off place for Ice Age nomadic hunters and food-gatherers.

Human remains in the rockshelter are rare and include only one possible human burial and some 30+ isolated occurrences of individual bones or teeth. The single human burial was recovered from a trash or refuse pit in a context suggestive of cannibalism. A higher level strata, from the Late Woodland period, disclosed a fully articulated dog skeleton which appears to have been intentionally buried.

The oval basin-shaped firepits, still containing charcoal and ash, and reddened by fire, have been the source of the charcoal used to establish the earliest dates by radiocarbon methods carried out by the Radiation Biology Laboratory of the Smithsonian Institution.

As of last summer, Meadowcroft yielded about 1,300 stone tools, 162 firepits and 29 refuse or storage pits.The bones, or bone fragments, numbered 211,818 from more than 65 animal species. Plant remains have been found from over 50 species and included 26,640 hackberry seeds.

The name of the rock shelter was derived from Meadowcroft Village, a restoration of a 19th century rural community established nearby by Albert and Delvin Miller on the farm which their great, great grandfather settled in 1795. Albert Miller had always been fascinated by the American Indians and over the years had collected a large number of artifacts. The shelter beneath the cliff had impressed him as a possible Indian campsite and upon probing the rubble strewn floor one day in 1969, he discovered some animal bones, fragmentary mussel shells, and a dozen chips of flint-like stone. He realized then he was right and knowing something about archaeology sought professional help as unskilled digging would have only ruined the fragile evidence of early man's occupation of the site.

A long time passed before Mr. Miller succeeded in finding a qualified archaeologist to investigate the rockshelter, but by the summer of 1973 test holes were drilled and the site proven. Dr. Adovasio and 14 students from Pitt began their painstaking work.

The story of the Meadowcroft Rockshelter is not over for the work of this past summer remains to be evaluated and firepits from lower levels may yield charcoal producing older radiocarbon dates. Prior to the discoveries at Meadowcroft, it was believed that the first Asian hunters migrated across the Bering Strait into Alaska during a period in which the ocean level was very low, exposing a land bridge. Several such periods are known to have occurred, the most recent around 13,000 B.C., or almost 15,000 years ago. Since Stone Age man was living at the Meadowcroft Rockshelter at least 16,000 years ago the crossings must have been made at an earlier time. The previous exposure of the Asia-to-Alaska land bridge is believed to have taken place from 23,000 to 28,000 years ago. It is during this time that the first migrations are now thought to have occurred.

We now have evidence that Stone Age man roamed western Pennsylvania as the Wisconsin ice front stalled near the present location of Butler and while to the northeast mastodons roamed the bogs of the Poconos.

New List [illegible]

Selected Earth Science Books is the title of a new pamphlet which has been published by the American Geological Institute in cooperation with the National Association of Geology Teachers. The list identifies outstanding recent reference books under the major subdivision of earth sciences: astronomy, geomorphology, earthquakes, economic geology, energy resources, environmental geology, glaciers, oceanography, regional geology, and physical geology. This list of major references will be of particular interest to schools, libraries, teachers, and earth science students. Single copies of the new pamphlet are available at no charge by sending a stamped, self-addressed business envelope to Dr. William H. Mathews III, Box 10031, Lamar University Station, Beaumont, Texas 77710.

Fossils in the Lock Haven Formation (Upper Devonian) Near Lock Haven, Pennsylvania

by Richard B. Wells and Jon D. Inners

One of the results of recent detailed geologic mapping in the Lock Haven-Jersey Shore-Williamsport area has been the definition of a new stratigraphic unit in the Upper Devonian deltaic sequence. Fossiliferous, marine rocks formerly called the "Chemung Formation" have been renamed the Lock Haven Formation, and a type section has been established along the east side of the West Branch, Susquehanna River, a few miles north of Lock Haven, Pennsylvania (Faill, Wells and Sevon, 1977; Taylor, 1977). In an inactive borrow pit near the top of the Lock Haven type section, large numbers of some invertebrate fossils diagnostic of the Upper Devonian in Pennsylvania can be collected. The beds in which the fossils occur are about 3600 feet above the contact of the Lock Haven Formation with the underlying Brallier Formation and about 200 feet below the base of the overlying Catskill Formation.

The collecting site is situated just south of the intersection of the Farrandsville road (L.R. 18014) with the Swissdale road (L.R. 18011) about 2.0 miles northwest of the Lockport-Lock Haven bridge, Woodward Township, Clinton Co. (Fig. 1). (Lat. 41° 09′ 50″ N, Long. 77° 27′ 54″ W, Lock Haven 7 1/2-minute Quad.). The land is owned by Mr. William E. Miller, who resides on the premises. Mr. Miller has granted permission for small groups to collect at the pit, but requests that they first stop at the house to announce their presence.

The rocks exposed in the borrow pit consist of light olive gray, sub-fissile to blocky clay shale with thin, blocky, rippled siltstone and very fine sandstone interbeds (Figs. 2, 3). In the middle of the exposure is a five-foot interval of medium bedded, cross-bedded sandstone with a prominent sand wave about 15 feet above the floor of the pit. Fossils are most numerous in the shaly beds below the sandstone unit. Since bedding dips about 40° to the north and is undercut by the excavation, new material for collecting is constantly being shed from the rock face and exposed on the surface of the outcrop. The fossils occur as molds and sediment casts which sometimes preserve fine details of the shell structures. A little carbonaceous material is sometimes associated with the casts of plant stems.

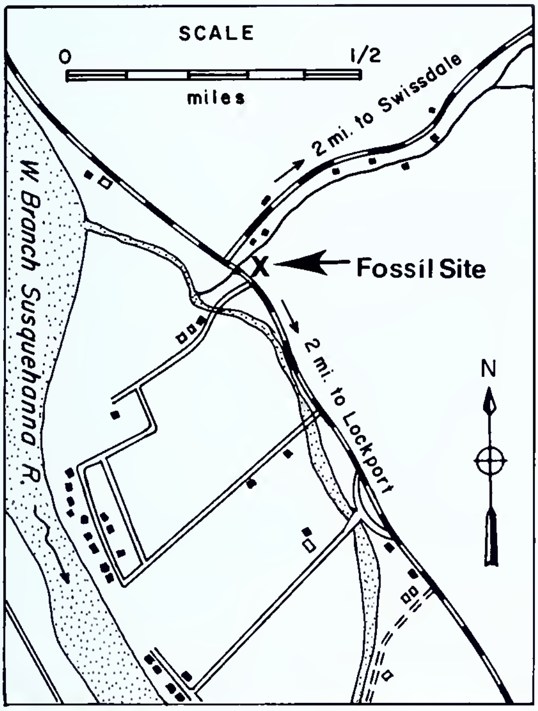
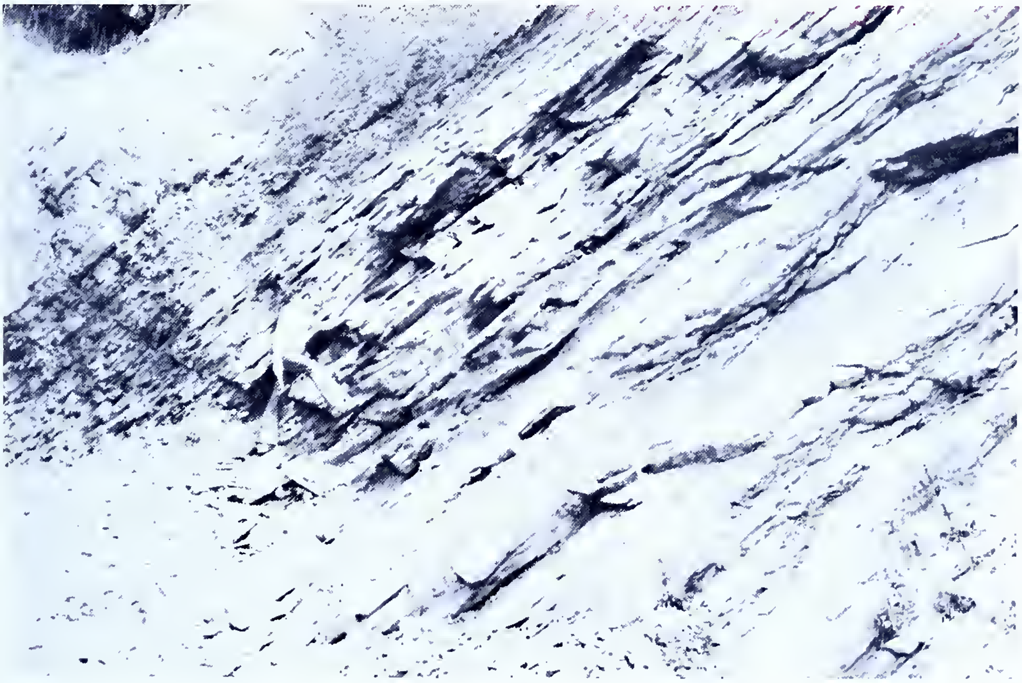


Fig. 1 Location map.

Fig. 2 Borrow pit in olive-gray shale with thin, very fine grained sandstone interbeds, near top of Lock Haven Formation at type section. Beds on right side of photo are very fossiliferous.



The faunal assemblage at this site has a rather low diversity, but several species are very abundant. The spiny productid *Productella lachrymosa* (Conrad) (Fig. 4) is the most conspicuous of the several large brachiopods which dominate the fauna. An unidentified species

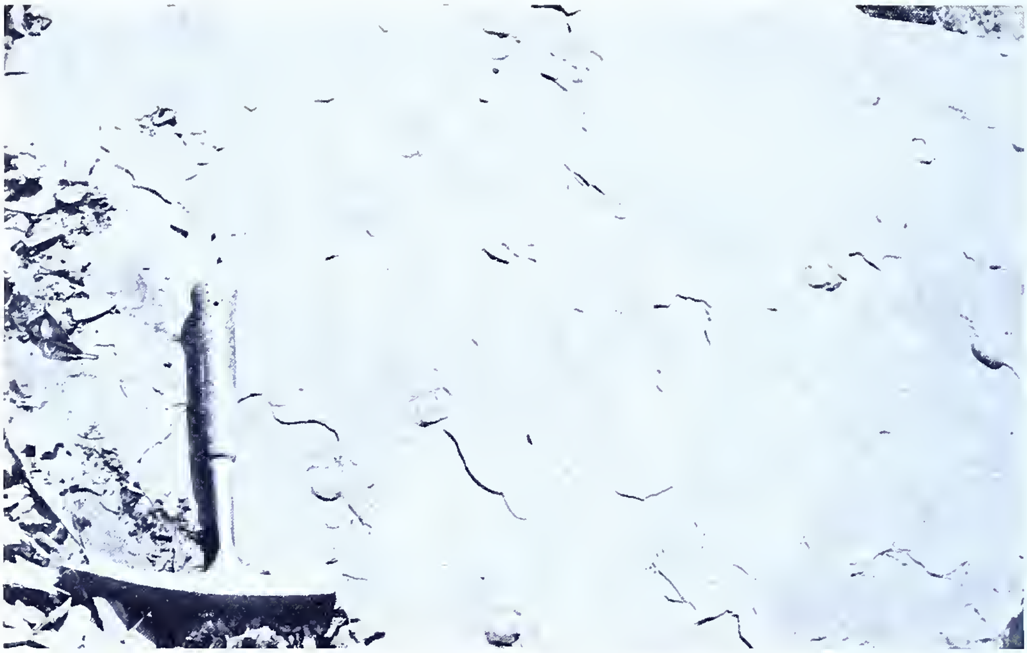


Fig. 3 Current-ripples in olive-gray, very fine grained sandstone of Lock Haven Formation at described site. Note brachiopod valves scattered convex-upward over surface of bed. (Current from right to left.)

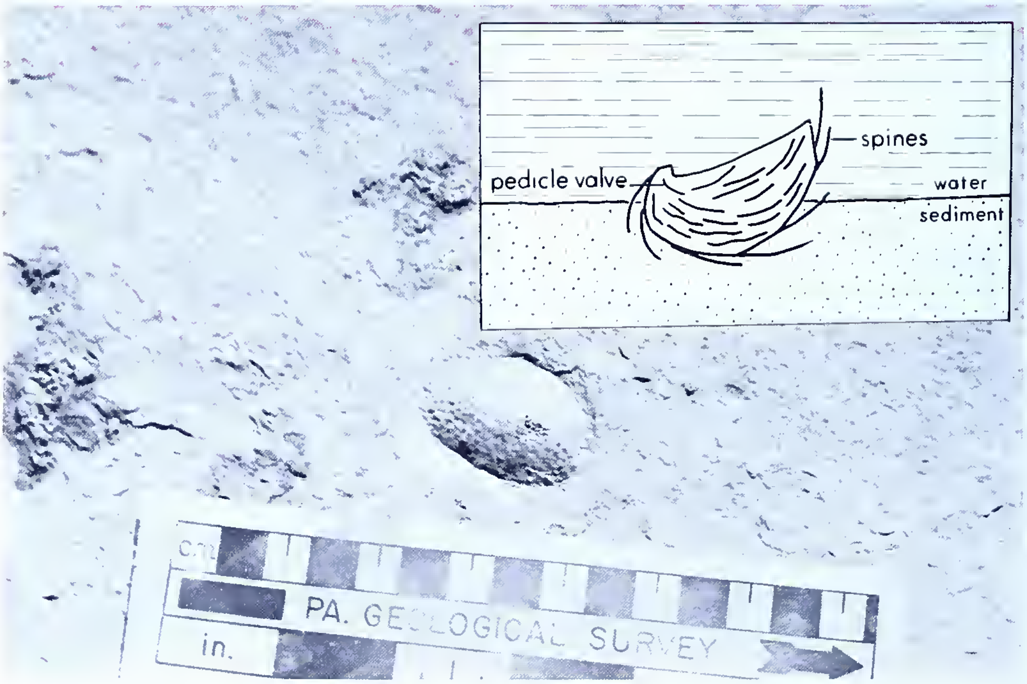


Fig. 4 *Productella lachrymosa* (Conrad) (internal mold of pedicle valve) on bedding surface. Insert in upper right shows this brachiopod in probable life position.

of the spiriferid genus *Cyrtospirifer*, an Upper Devonian guide fossil, is also well represented. A complete listing of the fossils collected by the writers is as follows (relative abundance shown by a=abundant; c=common; unc=uncommon;r=rare):

Bryozoans	
A fragile, branching type	(c)
Brachiopods	
Cyrtospirifer sp.	(c)
Tylothyris mesacostalis (Hall)	(unc)
Schellwienella chemungensis (Conrad)	(c)
Productella lachrymosa (Conrad)	(a)
Cupulorostrum sp.	(c)
Bivalves	
Leptodesma sp.	(c)
Cypricardella sp.	(unc)
Crinoids	
Stems and disarticulated columnals	(c)
Plants	
Casts of stems	(f)

These organisms probably inhabited waters of normal marine salinity in a nearshore, shallow subtidal environment. Except for *Cypricardella* sp., which was an infaunal filter feeder, the invertebrates listed above consist entirely of epifaunal filter feeders. Mild current and wave activity is indicated by ripple marks in the sandy beds, by the disarticulation of most of the specimens, and by the convex-upward pedicle valves of *Productella* scattered over the bedding surfaces (Figs. 3, 4). The fact that some articulated crinoid stems 16 inches or more in length were preserved in the sediment suggests that wave and current agitation was not great, however. The cross-bedded sandstone unit with sand-waves which overlies the fossiliferous shales may have been deposited in the intertidal zone, possibly in a small tidal channel.

Specimens from this site are available for study in the Paleontologic Reference Collection of the Pennsylvania Geological Survey.

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Taylor, Alfred R. (1977), Geology and mineral resources of the Lock Haven 7 1/2-minute Quadrangle, Lycoming and Clinton Counties, Pennsylvania: Pa. Geol. Surv., 4th Ser., Atlas Rept. 124a.

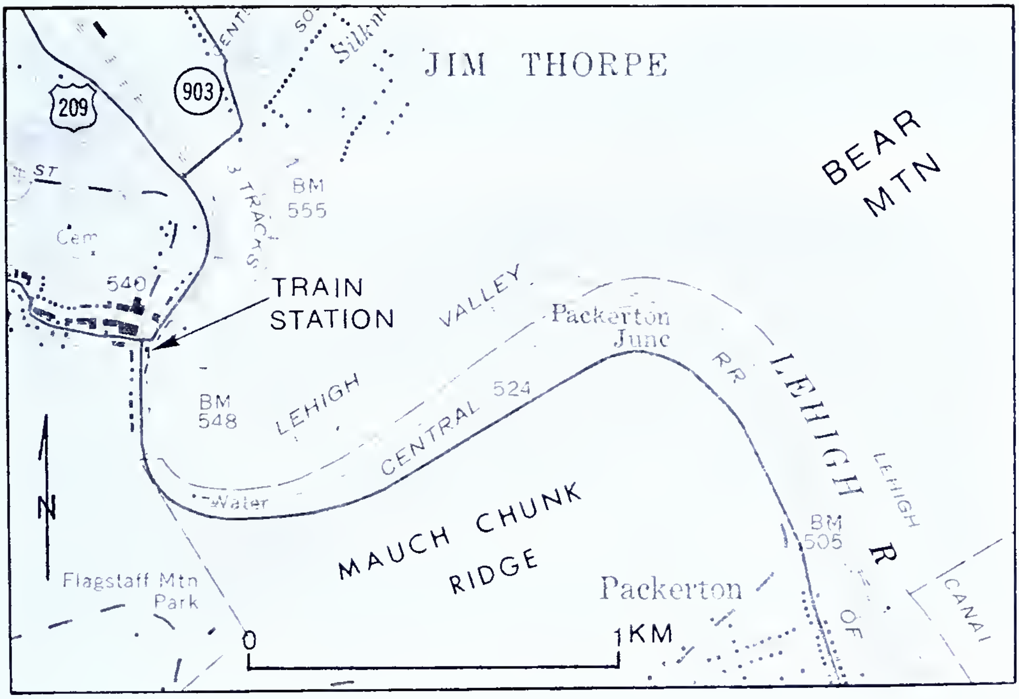
ZIMMERMAN URANIUM PROSPECT, CARBON COUNTY

Because of the recent interest in uranium occurrences in the Catskill Formation of Carbon County, the Pennsylvania Survey has located and sampled the previously noted but undescribed Zimmerman prospect on the east side of the Lehigh River, Jim Thorpe.

Klemic and others (1963, p. 83) list the occurrence as 1^E; they note that small amounts of malachite staining were observed in the radioactive rocks, and report that the area was prospected by Raymond Zimmerman of Weissport, Pennsylvania. The approximate location of 1^E is given on Plate 1 of U.S.G.S. Bull. 1138.

What is believed to be the Zimmerman prospect is located 1.55 km east of the train station in Jim Thorpe on the northeast side of the Lehigh River, and is approximately 340 m due east of center of a railroad bridge (Fig. 1). The prospect is reached by going 360 m to the southeast along a path from the northwest end of the railroad bridge, then approximately 30 m northeast from the path, to near the base of Bear Mountain. Seventy-five meters S65° E along the path from the prospect there is a large, wild rosebush on the southwest side of the path and 160 m southeast from the prospect along the path there is a large stone canal-lock pier. The latitude and longitude are 40°51′52″N, 75°43′11″W. The approximate elevation (estimated from the Lehighton 7-1/2′ topographic map) is 160 m.

The Zimmerman prospect consists of a single trench which is 8 m long, 0.5-2 m wide and 50 cm deep at most. The trench follows bedding which strikes N84° E and is vertical. The dump from the trench is on the south side. The dump has an overall radioactivity of only 0.05 mR/hr. A composite chip sample from the dump was found to contain 380 ppm U, 160 As, 200 Ba, 165 Cu, 8 Mo, 1,200 Pb, 35 Se, and 500 ppm V. All of these except Ba, Mo, and possibly V are strongly anomalous, showing that the rock is definitely mineralized. The unexpected, high concentration of the relatively immobile element Pb suggests that the U content may have been higher initially. Hand samples have an activity on contact of 0.5 to 1.0 mR/hr. The radioactivity in the trench itself is $\geqslant$ 0.1 mR/hr over a width of 40 cm. In the center of this, the activity on contact is 0.5 mR/hr. Carbonaceous seams up to 1 x 10 cm occur in the center of the zone.



The host rock to the uranium mineralization is a gray graywacke, which is quite phyllitic in some zones. Shale chips are sparse but present. The rock to the south of the trench is mostly reduced (grayish), and that to the north mostly oxidized (reddish). The lithology of uranium localization fits the observations of Schmiermund (1977). According to the mapping of Sevon (Epstein and others, 1974) the prospect would be located near the contact between the Clark's Ferry (braided-river system) and the overlying Duncannon (alluvial plain) Members of the Upper Devonian Catskill Formation.

Carbonaceous plant fragments are moderately common, but crumble readily because of intergrown pyrite. Pyrite also occurs in the graywacke matrix as fine-grained disseminations. Decomposition of the pyrite has yielded jarosite and limonite on many bedding and joint surfaces. No definite secondary uranium minerals were observed, possibly because of acidity from decomposing pyrite. The barest traces of a bright apple green secondary mineral could be weathered metatorbernite or malachite. Fluorescent green stains were observed with an ultraviolet light, but these are rare and cannot be correlated with observations under a binocular microscope.

There was no sign of chipping at the trench or dump, so the prospect probably has not been located by companies now working in the area. One boulder of pink conglomerate to the south is very slightly radioactive, and was chipped recently. The outcrops of reduced graywacke to the south are not noticeably radioactive with a geiger counter.

Bob C. Smith, II

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Epstein, J. B., Sevon, W. D., and Glaeser, J. Douglas (1974), *Geology and mineral resources of the Lehighton and Palmerton quadrangle, Carbon and Northampton Counties, Pennsylvania,* Pa. Geol. Survey, 4th ser., Atlas 195 cd.

Klemic, Harry, Warman, J. C., and Taylor, A. R. (1963), *Geology and uranium occurrences of the northern half of the Lehighton, Pennsylvania, quadrangle and adjoining areas,* U.S.G.S. Bull. 1138.

Schmiermund, R. L. (1977), *Geology and geochemistry of uranium deposits near Penn Haven Junction, Carbon County, Pennsylvania,* unpub. M.S. thesis, The Pennsylvania State University, University Park, Pa.

Western Pennsylvania Drainage Changes

Frank W. Preston's "Drainage Changes in the Late Pleistocene in Central Western Pennsylvania" has been published by the Carnegie Museum of Natural History, Carnegie Institute. Preston has aimed the book at local residents, visitors, naturalists and conservationists who would be interested in the changes which shaped such familiar places as McConnell's Mill State Park, Moraine State Park, Queens Junction, Lake Arthur, and the Slippery Rock Creek area. Dr. Preston is a scientist and nature lover who spent over a decade conducting the necessary field observations and research for this book.

In his account of the stages which occurred, Preston describes specific geographic features, the types of fossils which can be discovered and areas which have literally remained unchanged. This paperback book, with numerous photographs, illustrations and topographic maps is currently available in the Carnegie Museum of Natural History Gift Shop for $5.50 or by mail at $6.00 (includes postage) plus tax.

SURVEY ANNOUNCEMENTS

PENNSYLVANIA OIL AND GAS FIELDS MAP

With Pipeline Maps

Responding to the current interest and need for detailed, up-to-date data on Pennsylvania's oil and gas resources, the Pennsylvania Geologic Survey has issued a completely revised map showing the locations and boundaries of the 811 oil and gas fields of the Commonwealth. Published at a scale of 4 miles to the inch in multicolor on a large single sheet (40 x 56 inches), the reverse side of the oil and gas fields map carries updated maps of the oil and gas pipelines of Pennsylvania.

Map #3, Oil and Gas Fields of Pennsylvania, by William S. Lytle and Lajos J. Balogh, is available from the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125. The price is $2.30 (plus tax for Pa. residents).

1976 OIL AND GAS DEVELOPMENTS

The record of oil and gas drilling, production, and reserves for Pennsylvania in 1976 is presented in a report newly released by the Pennsylvania Geologic Survey. The 50-page book, entitled "Oil and Gas Developments in Pennsylvania in 1976", is co-authored by W.S. Lytle, Louis Heyman, R.G. Piotrowski, and S.A. Krajewski. This latest annual report on the subject provides data for the year as well as comparisons with activities in prior years. Particularly noteworthy was the drilling of 1262 new oil and gas wells and the production of 2.9 million barrels of crude oil and 76.6 billion cubic feet of natural gas.

Progress Report 190, *Oil and Gas Developments in Pennsylvania in 1976,* is available for $1.40 (plus 6% tax for Pa. residents) from the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125.

NEW GEOLOGIC ATLASES ISSUED

Four new Geologic Atlases have been issued by the Pennsylvania Geologic Survey for portions of Lycoming, Clinton, and Monroe counties. Each of the atlases contains detailed, full-colored geologic maps of the bedrock as well as the unconsolidated surficial deposits. The detailed maps (scale 1:24,000) and accompanying reports pay particular attention to the economic importance of the various geologic formations, as well as the engineering and environmental characteristics which will affect development and land use planning. These atlases will be of importance to residents of the areas, planners, local officials, industry, and conservationists.

Atlas 124a, *Geology and Mineral Resources of the Lock Haven Quadrangle, Clinton and Lycoming Counties,* by Alfred R. Taylor, is available for $5.55 (plus tax for Pa. residents).ents).

Atlas 133cd, *Geology and Mineral Resources of the Salladasburg and Cogan Station Quadrangles, Lycoming County,* by Rodger Faill, Richard Wells, and William Sevon, is available for $11.25 (plus tax for Pa. residents).

Atlas 134ab, *Geology and Mineral Resources of the Linden and Williamsport Quadrangles, Lycoming County,* by Rodger Faill, Richard Wells, and William Sevon, is available for $13.20 (plus tax for Pa. residents).

Atlas 204cd, *Geology and Mineral Resources of the Pocono Pines and Mount Pocono Quadrangles, Monroe County,* by Thomas Berg, William Sevon, and Milena Bucek, sells for $11.45 (plus tax for Pa. residents).

The above publications should be ordered from the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125.

GROUNDWATER REPORTS ISSUED

Three new groundwater reports have been published by the Pennsylvania Geologic Survey, dealing with Lancaster, Luzerne, and York counties. These reports provide basic data and descriptions and detailed hydrogeologic maps of the availability of subsurface water in the areas which were investigated. With a growing population and an expanding consumption of water by industry, these reports serve to focus attention on one of Pennsylvania's important, underdeveloped sources of quality water. These reports will be of assistance to planners, developers, and all future water users.

These reports are the products of an ongoing cooperative program with the Water Resources Division of the U.S. Geological Survey.

Water Resource Report 40, *Summary of Ground-Water Resources of Luzerne County,* by Thomas Newport, is available for $5.55 (plus tax for Pa. residents).

Water Resources Report 42, *Ground-Water Resources of Central and Southern York County,* by Orville Lloyd, Jr. and Douglas Growitz, sells for $10.95 (plus tax for Pa. residents).

Water Resources Report 43, *Summary of Ground-Water Resources of Lancaster County,* by Charles Poth, is available for $6.75 (plus tax for Pa. residents).

The above water resources reports should be ordered from the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125.

STONES FROM ALL THE WORLD – IN HARRISBURG

The diversity and origin of the many different types of stone which make up the buildings of the Capitol complex and other well known historical structures of the Greater Harrisburg area are the subject of a well-illustrated publication which has been released by the Bureau of Topographic and Geologic Survey. The new 47-page booklet is entitled "Building Stones of Pennsylvania's Capital Area", by Alan R. Geyer. Not only is the nature and source of the stone in each building carefully described, but a written guide for a walking tour is provided so that interested readers may proceed in sequence from building to building in the Harrisburg area.

Among the 45 outstanding structures reviewed in the new publication are such buildings and features as the Main Capitol Building (outside and inside), the Capitol statuary, Education Building, Labor and Industry Building, William Penn Memorial Museum, Boise Penrose Statue, Federal Building, Market Street Bridge, John Harris Mansion, Cameron Mansion, Pine Street Presbyterian Church, and the Civil War Veterans Monument. While some of the building stones were quarried in Pennsylvania, others have originated from such distant sources as Indiana, Tennessee, Minnesota, Alabama, Georgia, Vermont, Ireland, Italy, southern France, and Africa.

"Building Stones of Pennsylvania's Capital Area" (designated as Environmental Geology Report No. 5) is available for $0.95 (plus 6¢ tax for Pennsylvania residents) from the Pennsylvania State Book Store, 10th and Market Streets, P.O. Box 1365, Harrisburg, 17125.

STRATIGRAPHY OF WESTERN PENNSYLVANIA

The subsurface stratigraphy of western Pennsylvania has been refined and interpreted in the Pennsylvania Geological Survey's new report, *Tully (Middle Devonian) to Queenston (Upper Ordovician) Correlations in the Subsurface of Pennsylvania.* Authored by Louis Heyman, the report includes a text and 3 plates with 9 correlation sections based on lithologic and geophysical logs from oil and gas wells of western Pennsylvania.

The new data and interpretations will help to resolve some of the stratigraphic complexities of the regions and should be particularly helpful in the exploration for new oil and natural gas resources in Pennsylvania.

Mineral Resources Report M 73 is available for $3.60 (plus 6% tax for Pa. residents) from the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125.

COAL DATA PUBLISHED

The third in a series of comprehensive reports on the geology, chemistry, and physical properties of western Pennsylvania bituminous coal has been published by the Pennsylvania Geological Survey. *Analyses and Measured Sections of Pennsylvania Bituminous Coal, Part III* by V.K. Skema, W.E. Edmunds, A.D. Glover, J.D. Inners, and M.A. Sholes, provides detailed data on coal samples and related geology from approximately 200 sites in 20 counties of western Pennsylvania.

With increasing development of coal in Pennsylvania, the new data will assist coal producers, local officials, energy planners, and environmentalists in their respective activities.

Mineral Resources Report M 74, *Measured Sections of Pennsylvania Bituminous Coal, Part III,* is available for $3.65 (plus 6% tax for Pa. residents) from the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125.

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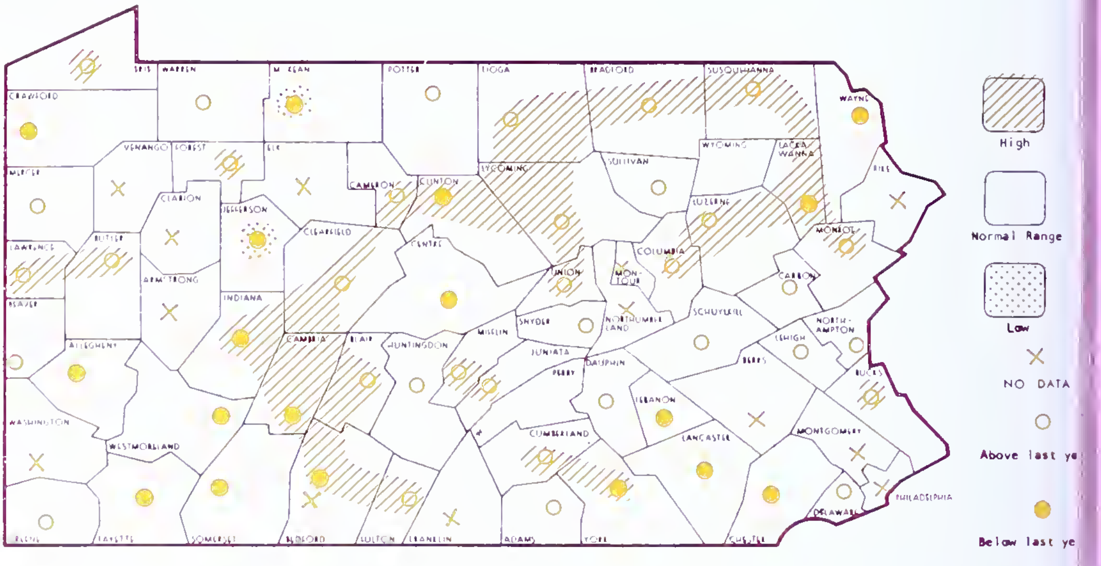

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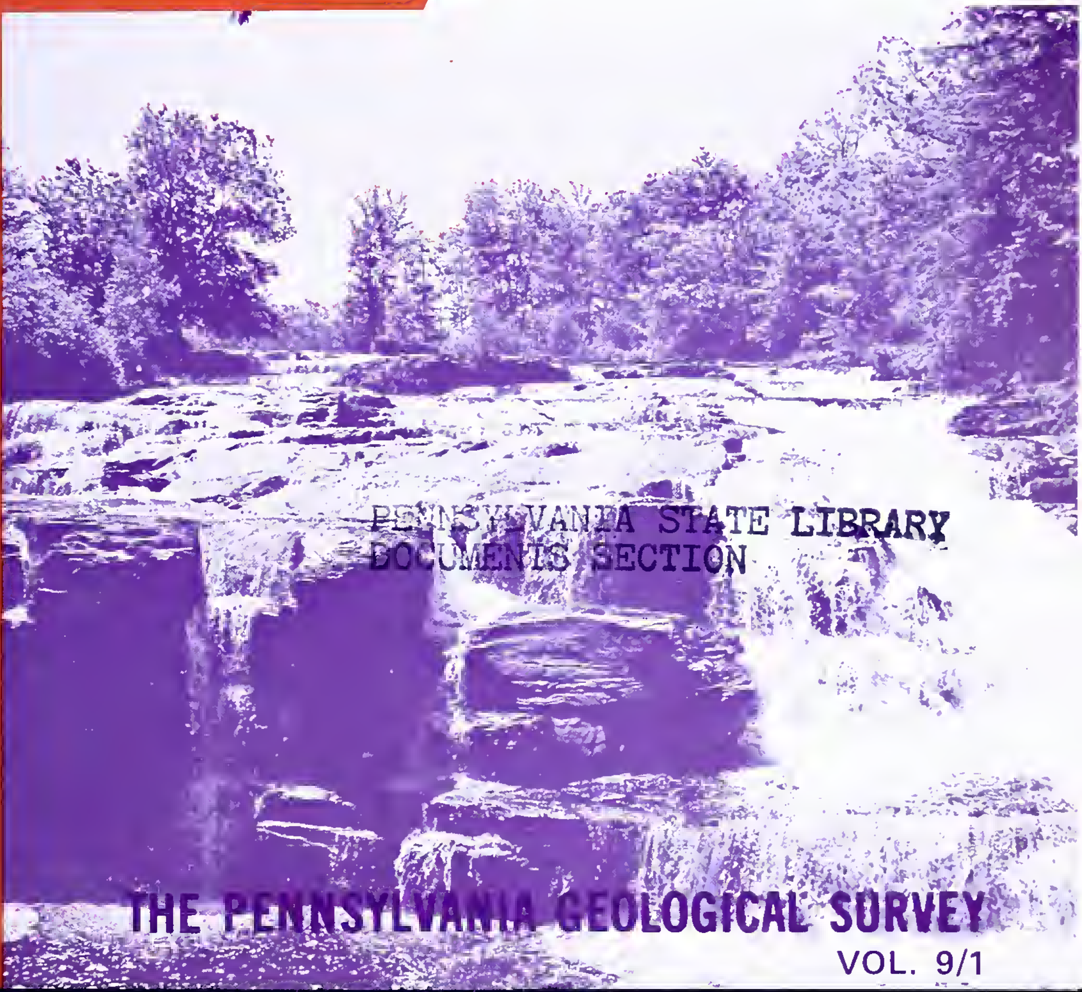

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THE PENNSYLVANIA GEOLOGICAL SURVEY

VOL. 9/1

COMMONWEALTH OF PENNSYLVANIA
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DEPARTMENT OF ENVIRONMENTAL RESOURCES
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TOPOGRAPHIC AND GEOLOGICAL SURVEY
Arthur A. Socolow, State Geologist

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ON THE COVER: Shohola Falls, on State Game Lands 180, along Route 6 approximately 9 miles northwest of Milford, Pike County. Shohola Creek descends 200 feet in half a mile over shales and sandstones of the Catskill Formation. Photo courtesy of William H. Bolles.

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FEBRUARY 1978

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

MINERALS – KEYSTONES OF OUR ECONOMY

The figures just released by the U. S. Bureau of Mines on the annual mineral production in Pennsylvania show that the Commonwealth has reached a new high. In 1977 Pennsylvania mineral production had a raw mineral value of $3.2 billion. This is just the value of the raw mineral matter, before it is processed into the finished products worth many times the raw value.

In this day and age of $500 billion dollar national budgets, Pennsylvania's mineral production value may tend to be overlooked, yet it is highly significant. Significant not just because it places us as the 5th largest mineral producer in the country, but significant because it constitutes the foundation for many major industries that are the mainstay of our economy. It is for that reason that in the trade, Pennsylvania's minerals are referred to as industrial minerals.

Our coal production (3rd largest in the country) keeps the generating plants operating and provides an essential raw material and fuel for our steel industry. Our limestone production furnishes the basic ingredient for our cement industry (#3 in the country), for our agricultural lime industry (#2 in the country) and for construction stone (#1 in the country) used in road building, housing, and commercial construction. Our clay production ends up in such "dull" products as bricks and sewer tile which are truly essential. Pennsylvania's oil and natural gas output, the nation's first such production in 1859, still yielded over $101 million dollars worth in 1977 and greatly contributed to our energy supplies.

Sand and gravel, not generally recognized as "glamorous," had a production value of $51 million last year in Pennsylvania, and was used for such diverse purposes as road construction, concrete, abrasives, and the basic raw material for making glass.

Even our one and only operating zinc mine produced ore values which place Pennsylvania seventh in national zinc ore production.

All in all, that $3.2 billion dollars worth of raw minerals produced in Pennsylvania last year, directly employing nearly 50,000 persons, and representing approximately twice the value of all of Pennsylvania's agricultural production, constitutes a basic foundation for our complex economy which goes on to utilize and expand the role of these essential mineral raw materials.

Arthur A. Socolow

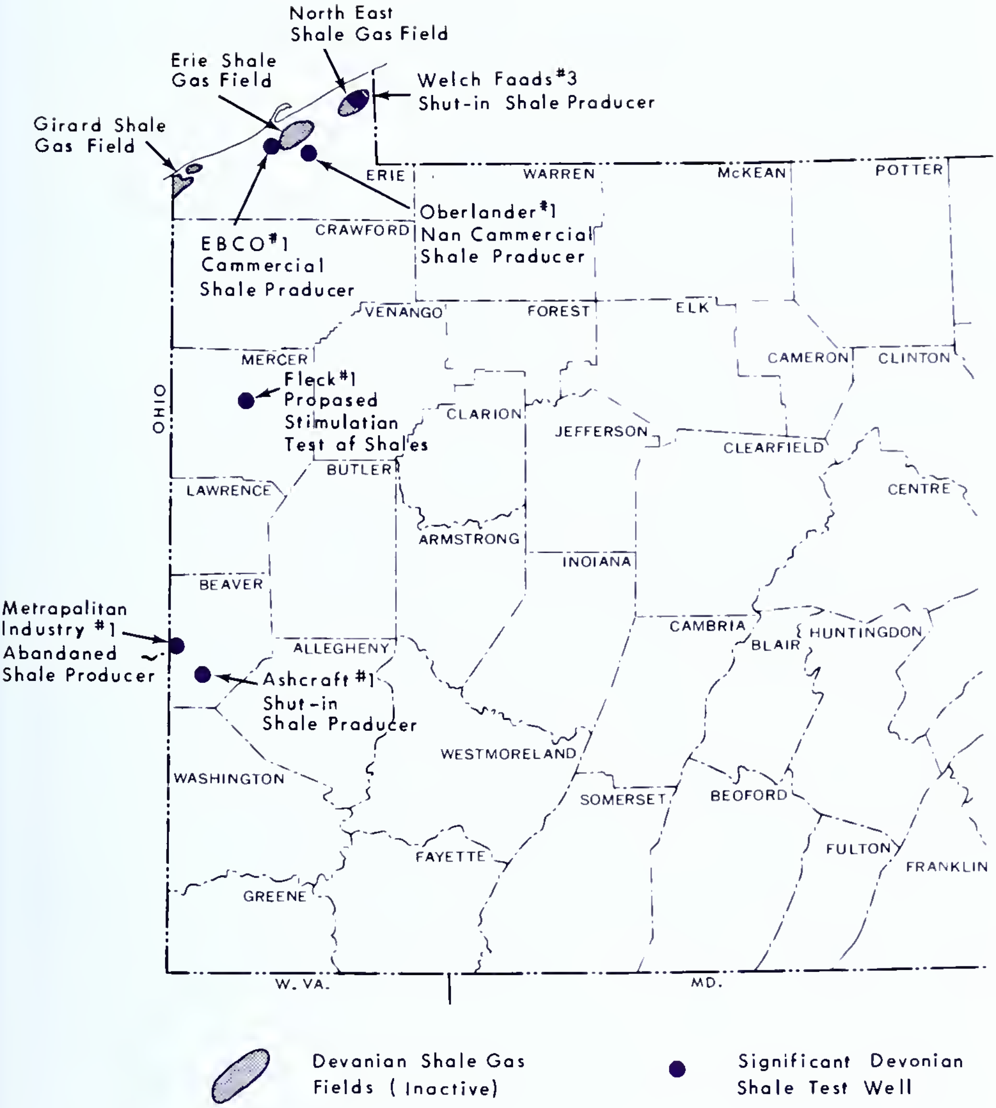
DEVONIAN SHALE GAS
new interest in old resource

by Robert G. Piotrowski

Black organic rich shales of Devonian age underlie a large portion of the eastern United States. In 1821, 38 years prior to the Drake oil discovery, the first well drilled in the United States specifically for natural gas was produced from these black shales. Gas from this well, located in Fredonia, Chautauqua County, in western New York State was used for street lighting. Between the discovery of this well in 1821 and at least until 1880, natural gas was produced from many shallow, low pressure wells in a belt along Lake Erie approximately six miles wide, extending from Dunkirk, New York, through Erie, Pennsylvania, to Sandusky, Ohio. However, other than some descriptive information, little data is available on these early wells.

In Pennsylvania, three shallow gas fields are indicated on old maps of Erie County. The Girard, Erie, and North East fields are part of the gas trend which extends along the Lake and which appears to be associated with the black shale. Locations and drillers' logs are not available for wells in the Erie and North East fields, and the actual limits of the fields are unknown. Some information is available for twenty wells which were drilled in the Girard field. This includes locations, depths, and initial open flow rates. These twenty wells were drilled in 1941 by the Ohio Oil Company in Springfield Township, Erie County, Pennsylvania, and Conneaut Township, Ashtabula County, Ohio. The wells range from 500 to 800 feet deep and had gauged open flow rates of gas from a low of 116,000 cubic feet per day to a high of 4,168,000 cubic feet per day. Unfortunately, the production history of these wells is unknown.

Spurred by the energy situation and rising natural gas prices a renewed interest has been shown in the possible development of the gas resources in the Devonian organic rich black shales. In February 1975, Quaker State completed the #1 Metropolitan Industry well in Beaver County, Pennsylvania, as a Devonian shale discovery. The well was drilled to the Queenston Formation and plugged back to a depth of 4500 feet to test Devonian shale. The well had no natural gas production from the shale, but had an initial potential of 150,000 cubic feet per day at 1150 pounds rock pressure after hydraulic fracturing. When put on line for production, however, the well did not last long. The well delivered 150,000 cubic feet of gas the first day and declined each day thereafter until at the end of 30 days, it


North East Shale Gas Field
Erie Shale Gas Field
Welch Foods #3 Shut-in Shale Producer
Girard Shale Gas Field
ERIE
WARREN
McKEAN
POTTER
Oberlander #1 Non Commercial Shale Producer
CRAWFORD
EBCO #1 Commercial Shale Producer
VENANGO
FOREST
ELK
CAMERON
CLINTON
MERCER
Fleck #1 Proposed Stimulation Test of Shales
OHIO
CLARION
JEFFERSON
CLEARFIELD
BUTLER
LAWRENCE
CENTRE
ARMSTRONG
INDIANA
BEAVER
Metropolitan Industry #1 Abandoned Shale Producer
CAMBRIA
HUNTINGDON
BLAIR
ALLEGHENY
Ashcraft #1 Shut-in Shale Producer
WESTMORELAND
WASHINGTON
SOMERSET
BEDFORD
FULTON
FRANKLIN
FAYETTE
GREENE
W. VA.
MD.
Devonian Shale Gas Fields (Inactive)
Significant Devonian Shale Test Well

MAP SHOWING LOCATIONS OF SIGNIFICANT DEVONIAN SHALE WELLS AND FIELDS IN PENNSYLVANIA

FIGURE 1.

was non-productive. When shut in, the pressure would build up, but on opening the well it would blow down to nothing in a short time. Evidently, there was very little original porosity. Gas accumulated in fractures induced when the well was completed by hydraulic fracturing, but the extent of this induced fracture system does not appear to be extensive enough to constitute an adequate reservoir for commercial production. The well has been plugged and abandoned.

In December 1975, St. Joe Petroleum Corp. completed the #1 Ashcroft well in Beaver County. The well was drilled to the Queenston Formation and plugged back to a depth of 5145 feet to test Devonian shale. The well had small gas shows in the shale and was hydraulically fractured. The well history is similar to the Metropolitan Industry well mentioned above in that the gas blows down very quickly, but when shut in the pressure builds back up. It appears that the gas accumulates in the relatively small fracture reservoir induced when the well was completed by hydraulic fracturing. This well is currently shut in.

In September 1976, the Welch Foods #3 well was drilled by Moody & Associates as a 900 feet Devonian shale test. The well is located near Lake Erie within the old North East shale gas field, and may be a model for the type of production which occurred along the Lake. The well had a natural gas flow of 12,000 cubic feet per day and a flow rate of 150,000 cubic feet per day with an 80 pound rock pressure after a foam fracture. A sibilation log run in this well indicates the presence of an apparent natural fracture system from which gas enters the bore hole. It appears that the organic rich shales are the source of gas, and the natural fracture system serves as the reservoir. It is also observed that the fracture system is partially within the black shales and partially within the overlying gray shales. After a one month period of testing, the well is reported to have flowed only 3500 cubic feet per day and is currently shut in. The reason for the drop off in production is unknown. It may be that the shales are depleted locally since the well is in the old North East field. Only further drilling and testing will determine this.

In April 1977, Henry Oberlander completed a Devonian shale well on his farm. The well encountered a good gas show at 300 feet and was completed at a total depth of 800 feet. This well was gauged at 4000 cubic feet per day natural production. Although this is a relatively small volume, the well has been hooked up and should be adequate for domestic use.

In November 1977, the EBCO #1 well was drilled by Moody & Associates just west of the old Erie shale gas field. This well was drilled to a total depth of 900 feet into the Devonian black shales. The well encountered three significant gas shows while drilling. The first show of gas occurred at 381 feet. Drilling was temporarily halted to let the gas blow down, and after 2 hours of open flow 1,300,000 cubic feet per day of gas was recorded. The second show occurred at 533 feet and a flow of 1,700,000 cubic feet per day of gas was noted after 2 hours of open flow. The third show was encountered at a depth of 731 feet and a gas flow of 1,300,000 cubic feet per day was gauged after 1 hour open flow. After completion of drilling to 901 feet on November 9, 1977, a 2 hour natural open flow test was conducted on the well after it had been shut in for five days and had a pressure of 100 pounds. At the end of 2 hours of open flow, a flow rate of 975,000 cubic feet per day of gas was measured. The well was then shut in and a pressure of 60 pounds noted. By November 11 (2 days) the pressure had increased to 120 pounds. Both sibilation and temperature logs run through the shale section in nearby wells and the behavior of this well indicate the presence of an apparent natural fracture system which serves as the gas reservoir. The organic black shales are the probable gas source. It is impossible at this time to predict the potential of the #1 EBCO well. It does appear, however, to be capable of producing enough gas to initially meet the natural gas needs of the Erie Burial Case Company for whom it was drilled. Moody & Associates have recommended that the well be hooked up and used for 1 year while maintaining records of gas volumes used and shut in pressures. The data from this production period could then be used to predict more accurately the total recoverable gas reserves of this well, and to provide some production history for any additional shale wells which may be drilled in the area.

The U. S. Department of Energy is currently conducting an extensive study into the natural gas potential of the Devonian shales in the entire Appalachian Basin. A listing of all participants in the Department of Energy study and a summary of all contracts is available in the report, "Summary of Contracts for the Eastern Gas Shale Project" published by the U. S. Department of Energy, Morgantown Energy Research Center, Morgantown, WV. The Pennsylvania Geological Survey is also cooperating with the Department of Energy and is contracted to provide stratigraphic data on the shales. A summary of this work, which is in preparation, is available in Pennsylvania Geological Survey Progress Report 190, "Oil and Gas Developments in Pennsylvania in 1976." The Department of Energy is also cooperating with Peoples Natural Gas Co. in a planned stimulation of the Devonian shales in Peoples' #1 Fleck well in Mercer County.

The Devonian organic-rich shales appear to be an important resource in northwest Pennsylvania. The energy shortages of the past few years and the rising price of natural gas should make the shales a more attractive drilling target in the near future. The shales are shallow in depth, have a widespread occurrence, and a long production life. They have excellent potential to fill the needs of small commercial, light industrial, and individual users. The development of better technology for inducing and enhancing fracture systems will also have a substantial effect upon the exploitation of this resource.

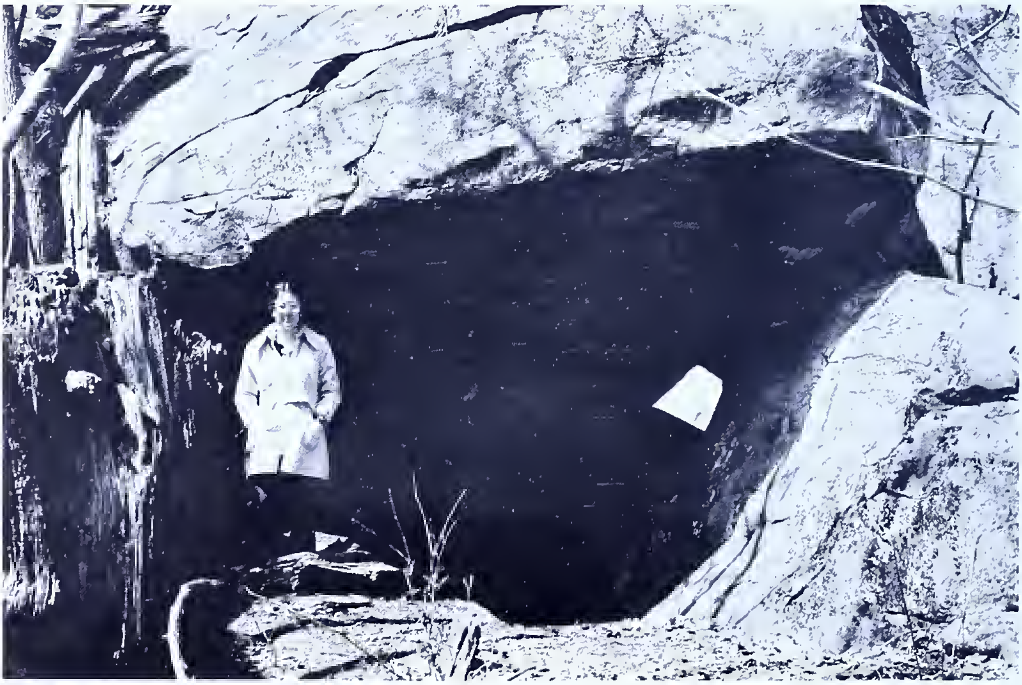
GOVERNOR'S STABLES

by William H. Bolles
Department of Education

At Governor's Stables in eastern Lancaster County large diabase boulders have been weathered in such a manner as to produce a "boulder cave." The rounding of the boulders is due to the exfoliation of thin surfical layers; the same process which formed the famous "Devil's Den" diabase boulder cave on the Gettysburg Battlefield.

Two legends are attributed to the naming of this cave. One claims that prior to 1800 a horse thief, known as "The Governor" used the cave as his headquarters. The other legend claims that Andrew Curtin, Governor of Pennsylvania from 1861 to 1867, took shelter here along with some of his aides when a violent storm caught them while traveling the Falmouth-Elizabethtown Pike on their way from Lancaster to Harrisburg.

The boulder cave is a rectangular room 29 feet by 7 feet and up to 15 feet high, formed by two vertical-standing boulders capped by



The boulder cave which is known as Governor's Stables in Conoy Township, Lancaster County.

a third. Additional boulders partially close the ends of the room. A split in the capping boulder, perpendicular to the long-axis of the room, forms a convenient natural chimney.

Governor's Stables may be reached from Falmouth by traveling one mile northeast on the Falmouth-Elizabethtown road. Turn south on a dirt road and proceed 0.3 miles, then turn off to the southwest and park outside the gate. Follow the road and trail southwest for about 1000 feet until it terminates at a large boulder-strewn slope. The cave is at the base of this slope, 250 feet north of Stony Run.

These boulders are part of a Triassic diabase intrusive sheet (commonly called ironstone) which appears along the northwestern boundary of Lancaster County and Dauphin County.

Among The Many Requests Received...

The Pennsylvania Geological Survey receives requests for many kinds of geologic information and services. Some are more difficult than others. For example, the following letter came from Georgia:

> "Gentlemen:
>
> My 11-year old son came home from school yesterday with your address and not much more information. (Knowing you can't get too much information anyway out of a boy that age).
>
> Be that as it may, he informed me I was to write to you and ask you to send him something his teacher told to send for (what I don't know).
>
> If you would send whatever it is, and if there are any charges, please advise.
>
> Thank you in advance.
>
> Most Sincerely,"

This was a tough one. We did our best and hope that both parent and son received what they wanted.

NEW CEMENT PLANT

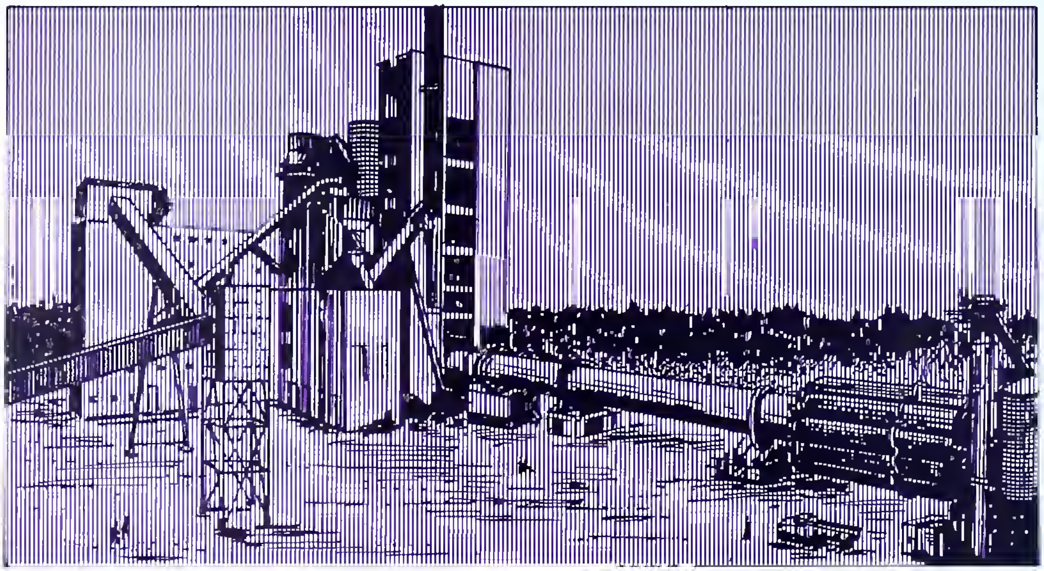
The business section of the December 25th issue of the *New York Times* carries an article by Victor K. McElheny on new cement plants across the country. The following has been taken directly from the article:

"Pursuing both higher output and lower costs, large and small cement companies are scrapping costly, energy-gobbling older plants and are building new ones, often adopting advanced energy-saving technology borrowed from Europe."

"There is plenty of incentive for the $2.8 billion cement industry to install new production capacity. Many of its plants are antiquated, a condition that exerted a heavy drag on earnings in 1973-75, when housing starts and construction generally went into a tailspin."

"Thanks to a resurgence of demand during the last two years, however, cement shipments are up about 6 percent and are expected to gain 5 percent more in 1978. By 1980, when several of the new plants will be starting to produce, the industry may be operating at as much as 90 percent of capacity -- a level rarely reached since the big construction boom of the 1950's."

"Major new projects include a $55 million plant being built at Nazareth, Pa., by the Coplay Cement Manufacturing Company. This installation, with capacity of 1.1 million tons of cement a year, will replace 11 smaller plants — seven of them built more than half a century ago."



"By old technological standards, the new kilns are huge. The one Coplay is installing at Nazareth, for example, is almost 17 feet in diameter and 276 feet long."

"The new plants -- and the new technology -- promise not only significant fuel savings but also major economies of scale. The new installations, typically five times the size of those they displace, are expected to halve the energy use per ton of output by improved handling methods and other techniques that recycle heat from the kilns back to a series of pre-heaters."

"Much of the capital that is going into new cement plants is coming from banks. The cement industry has always relied heavily on borrowed money for expansion, but a series of takeovers has also given some of the producers easier access to capital."

"Coplay Cement Manufacturing was acquired in 1976 by Eurocem Inc., an American subsidiary of one of the largest French cement manufacturers, the Societe des Ciments Francais."

"Lehigh Portland Cement, with headquarters in Allentown, Pa., was taken over two months ago by Heidelberg Cement Inc., an American subsidiary of Portland-Zementwerke Heidelberg A.G. of West Germany."

ERIE GAS FIELD REDEFINED

A large increase in the number of gas wells completed with very small final open flows in an area formerly considered as essentially non-commercial necessitates redefinition of the extent of the Erie gas field, Erie County, Pa. This field as currently defined is number 389 on the 1977 edition of the Oil and Gas Fields Map of Pennsylvania.

The Erie gas field is redefined as comprising all gas production west of 79°55′, east of 80°15′, and north of 41°55′, excepting McKean field, no. 386; Blass pool, no. 387; Summit storage (Meade field), no. 388; and the unnumbered recently discovered Glenwood, Fairview and Charter Oaks fields. Glenwood is between Erie and the Summit storage area; Fairview is about 9 miles southwest of Erie; Charter Oaks is about 3 miles southwest of Erie. All production from rocks above the Tully Limestone or equivalent will be designated Erie field shallow; all production from and below the Tully will be designated Erie field deep.

This redefinition is intended to avoid a proliferation of field and pool names resulting from a multiplicity of so-called new field or new pool discoveries in this area.

A McKENZIE EURYPTERID

by Emily B. Giffin

A specimen of the eurypterid genus *Eurypterus,* cf. *E. remipes* has been found in the McKenzie Member of the Mifflintown Formation. The specimen (Figure 1) is small, with a total length of only 5.9 cm. Although all of the appendages are missing, the cephalothorax and abdomen are reasonably well-preserved, and lack only the telson, or last abdominal segment.

Eurypterids are among the rarest of Pennsylvania's fossils, the only sizeable collection being the *Lepidoderma* specimens from the Carboniferous Darlington beds of Beaver County. This new find is unusual in that only one other eurypterid, identified as *Eurypterus maria,* has ever been reported from the McKenzie beds of Pennsylvania (Swartz and Swartz, 1930). This specimen, which is of uncertain stratigraphic position, was collected by Dr. Gilbert Van Ingen at the old Swatara Gap section north and east of the old Swatara Creek Bridge.

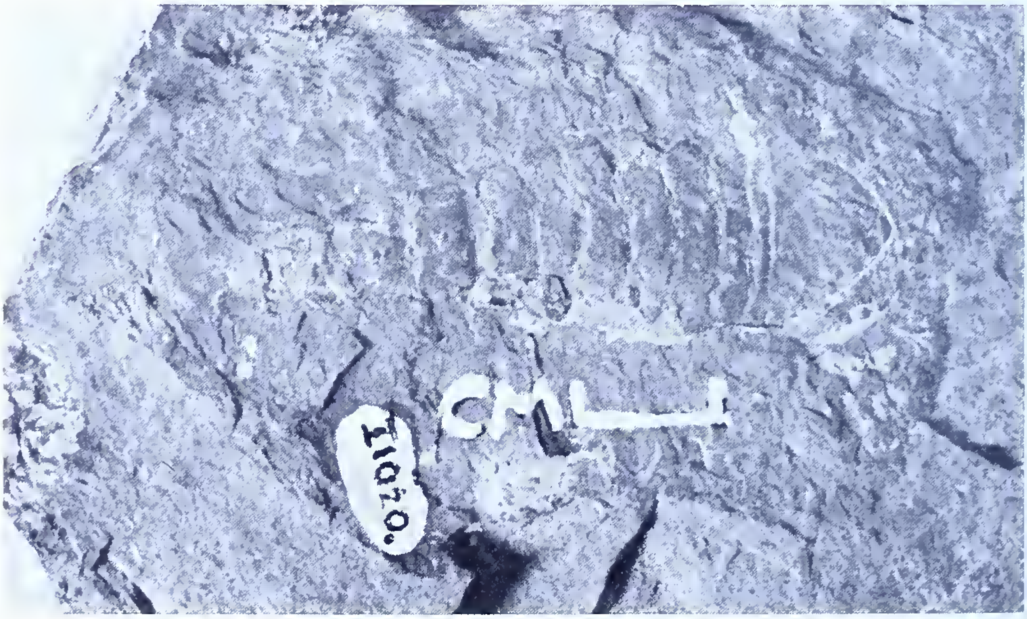


Fig. 1 *Eurypterus* **cf.** *E. remipes* **from the McKenzie Member of the Mifflintown Formation. Scale = 1 cm.**

Eurypterids have been a source of curiosity and interest ever since the first specimen was described in 1818. Although this first fossil was identified as a catfish, more recent studies have recognized that the group belongs among the Arthropoda, or jointed-leg animals.

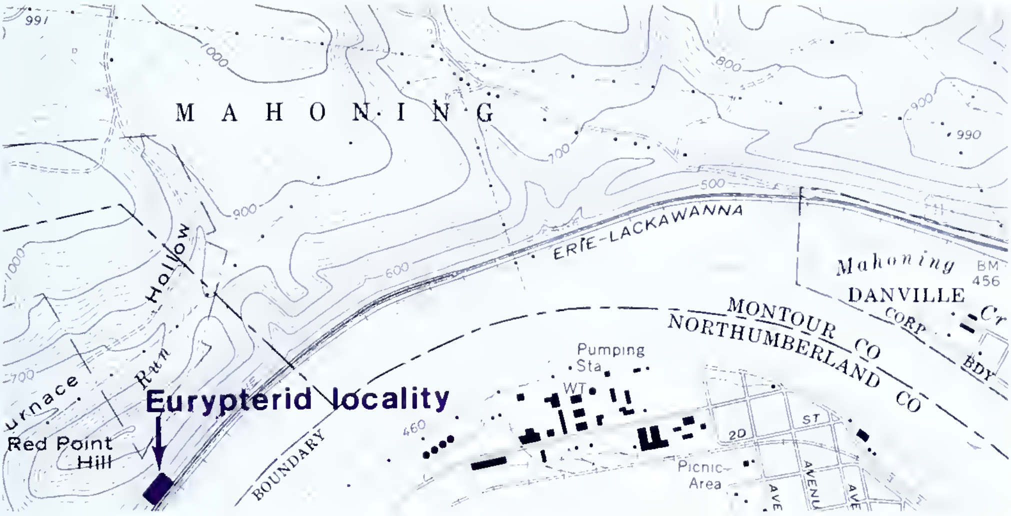


Fig. 2 Location of eurypterid find.

The presence of pincers (chelicerae) identifies eurypterids as members of the Subphylum Chelicerata, and suggests that they are most closely related to the horse-shoe crab and spiders among living arthropods.

The eurypterid reported here was found just west of Danville, where a large road cut on the north side of Route 11 exposes almost the entire Silurian section. The specimen was collected from float in the McKenzie Member of the Mifflintown Formation, about 1.0 miles west of the Northumberland/Montour County line (Figure 2). The lime, medium-gray shale matrix is otherwise unfossiliferous, and is typical of the shale beds that alternate with limestones in the lower part of the McKenzie Member. The shale indicates the presence of mud in the environment of deposition, and suggests that these sediments were deposited in marine seas that lay offshore a coastal plain (Folk, 1962).

The McKenzie has been correlated with difficulty with the classic Silurian section of New York. The sparse fauna, the differences in facies, and the resulting differences in what little fauna that is present have all posed major problems for correlation. Frank M. Swartz (1935) suggested that the McKenzie of Pennsylvania is the time equivalent of New York's Lockport Group largely on the basis of similarities in meagre ostracod faunas. The Lockport correlation is supported by Zenger (1965). In contrast to the McKenzie, the Lockport sequence is more truly marine, and its sediments were probably deposited in more open parts of the sea. Consequently, its fossils are those of animals adapted to this open sea environment.

Eurypterids are known from at least three environmental regimes: a completely marine habitat, a habitat intermediate between normal marine and brackish, and a fresh to brackish habitat (Kjellesvig-Waering, 1961). The Family Eurypteridae, and thus the genus *Eurypterus,* is typical of the second group, and it is in this intermediate habitat group that the McKenzie beds may be placed.

In contrast, the more truly marine beds of the Lockport Group can be placed in the first, completely marine habitat. Rare eurypterids have been reported from the Lockport Group. Zenger (1965) reported *Eusarcus* (now referred to the genus *Carcinosoma*) from the Sconondoa Member of the Lockport, and Williams (1915) reported the same genus from the Eramosa Member of neighboring Ontario. *Carcinosoma* is found only in marine beds, and is grouped by Kjellesvig-Waering (1961) among eurypterids typical of the most marine environments.

Although one might expect that a new fossil find would aid in correlation problems, it is of limited help here. Certainly *Eurypterus* in the McKenzie and *Carcinosoma* in the Lockport are compatible with time equivalency. However, each has a considerable time range and distinct environmental preference. Thus, even among eurypterids, the facies problem that has prevented easy McKenzie/Lockport correlations is very evident.

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YORK MINERAL AND GEM SHOW

The York Rock and Mineral Club will hold its Ninth Annual Mineral and Gem Show on Saturday, April 1 and Sunday, April 2, 1978 at the Manchester Township Fire Company #1, in the Manchester Township Building, Emigsville, Pa. The firehouse is located in Emigsville, Pa. on Route 181, going north from York, Pa. Show hours are Saturday, April 1 – 10 AM to 9 PM and Sunday, April 2 – 10 AM to 6 PM. Admission will be 75¢ – children under 12 free.

SURVEY ANNOUNCEMENTS

REPORT ON ZINC AND LEAD OCCURRENCES IN PENNSYLVANIA

A thorough field and literature review has been made of all previously reported zinc and lead occurrences in Pennsylvania, as well as a considerable number of occurrences never previously reported. The results of this investigation by Dr. Robert Smith, II, covering over 100 occurrences in 19 counties, have been released by the Bureau of Topographic and Geologic Survey in its new Mineral Resources Report 72, *Zinc and Lead Occurrences in Pennsylvania.* This report updates and revises B. L. Miller's classic report published by the Survey in 1924. The nineteen counties in which the occurrences are located are: Bedford, Berks, Blair, Bucks, Centre, Chester, Columbia, Cumberland, Huntingdon, Jefferson, Lancaster, Lehigh, Lycoming, Montgomery, Northampton, Northumberland, Sullivan, Union, and York.

The new report suggests the most favorable counties and geologic formations for mineralization and provides detailed geologic and mineralogic data for each of the occurrences. The report will be of use to zinc and lead exploration companies, land-use planners, environmentalists, mineral collectors, historians, and the property owners themselves.

Mineral Resources Report 72 is available from the State Book Store, 10th and Market Streets, P. O. Box 1365, Harrisburg, PA 17125. The price is $11.50 (plus 69 cents tax for Pennsylvania residents); for mail orders, a check or money order payable to "Commonwealth of Pennsylvania" should be enclosed.

HARRISBURG WEST SHORE GEOLOGY

A comprehensive 106-page text and full-color geologic map of the Harrisburg west shore geology has been published by the Pennsylvania Geological Survey. Authored by Dr. Samuel I. Root, *Geology and Mineral Resources of the Harrisburg West Area, Cumberland and York Counties,* provides environmental, engineering, and geological details which will benefit property owners, land use planners, engineers, and the mineral industry of the area.

Atlas 148ab is available from the State Book Store, P. O. Box 1365, Harrisburg, Pa. 17125, for the price of $9.65 (plus 6% tax for Pennsylvania residents).

DIRECTORY OF MINERAL INDUSTRY IN PENNSYLVANIA

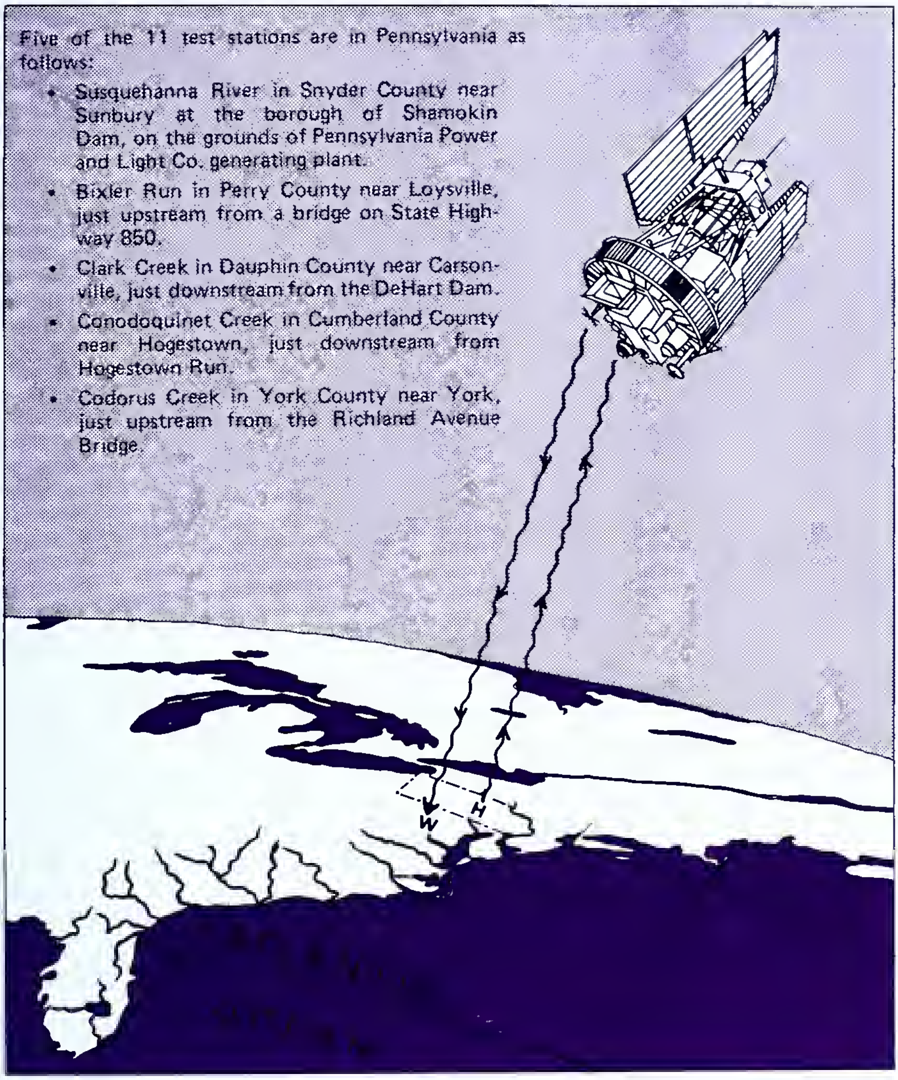
Responding to the demand for updated information on the mineral industry in Pennsylvania, the Pennsylvania Geological Survey has issued a completely revised edition of the *Directory of the Mineral Industry in Pennsylvania*. The directory is divided into three parts. Part 1 lists producers according to the mineral raw materials being produced. Part 2 consists of a listing of the mineral producers on a county by county basis, with the active quarries and plants keyed to an accompanying location map at a scale of 1:500,000 (1 inch equals approximately 8 miles). The kind of rock (limestone, sandstone, diabase, etc.) being extracted or the mineral commodity (cement, etc.) being produced at each locality is indicated by symbol on the map. Part 3 of the directory is a company index arranged alphabetically.

The *Directory of the Mineral Industry in Pennsylvania,* third edition, by Bernard J. O'Neill, Jr., is available from the State Book Store, P. O. Box 1365, Harrisburg, Pennsylvania 17125. The price is $4.10, plus 6% state sales tax if mailed to a Pennsylvania address. Checks are to be made payable to the Commonwealth of Pennsylvania.

water data relay by commercial satellite to be tested

A six-month demonstration using a commercial communication satellite to relay water data from 11 U. S. Geological Survey's stream monitoring stations will be conducted by the U.S.G.S. with the help of COMSAT General Corporation starting in October, 1977. The COMSAT General demonstration will test the feasibility and cost of using commercail rather than government satellites to relay the hydrologic data to receiving stations. The Survey may eventually integrate all 9,000 of its monitoring stations into a satellite data retrieval system to replace the present method of manually retrieving data tapes from the battery-powered monitoring stations at intervals of four to six weeks.

A satellite retrieval system would have two principal advantages: it would permit processing and retrieval of hydrologic data from U.S.G.S. computers almost immediately after collection rather than after a four to six week delay, and it would free U.S.G.S. personnel from manual collection duties for research and other projects.



Five of the 11 test stations are in Pennsylvania as follows:

- Susquehanna River in Snyder County near Sunbury at the borough of Shamokin Dam, on the grounds of Pennsylvania Power and Light Co. generating plant.
- Bixler Run in Perry County near Loysville, just upstream from a bridge on State Highway 850.
- Clark Creek in Dauphin County near Carsonville, just downstream from the DeHart Dam.
- Conodoquinet Creek in Cumberland County near Hogestown, just downstream from Hogestown Run.
- Codorus Creek in York County near York, just upstream from the Richland Avenue Bridge.

COMSAT General, a subsidiary of the COMSAT Corporation, will use, for this demonstration only, a Telesat of Canada ANIK geostationary communication satellite. The ANIK satellite is stationary above the equator at 104 degrees west longitude, which is almost directly south of Guadalajara, Mexico and Carlsbad, New Mexico.

The water information from Pennsylvania is gathered and used in cooperation with the Pennsylvania Department of Environmental Resources to tackle a growing number of water problems such as: Are stream flows adequate to meet water supply needs or to dilute downstream waste discharges? Do high flows upstream threaten downstream communities? If a chemical is spilled into a stream, how fast will it move downstream to a public water supply? Is the quality of the water changing and will it affect users?

NEW FROM THE U.S. GEOLOGICAL SURVEY AND BUREAU OF MINES

U. S. G. S.
Circular 728

Landsliding in Allegheny County, Pennsylvania, by R. P. Briggs, and others.

The report includes a discussion of landsliding causes and evidence of landsliding, including brief descriptions of specific landslides. Free.

Miscellaneous Investigations Series

Map 1-1035 Landslide Susceptibility Map of Pittsburgh West Quadrangle, Allegheny County, Pennsylvania, by J. S. Pomeroy.

The map identifies with potential slope-stability problems significant to development. It is a guide to areas of past landsliding and present susceptibility. Cost $1.25.

Order from: Branch of Distribution, U. S. Geological Survey, 1200 South Eads St., Arlington, Va. 22202. For cost publications send check or money order.

U. S. B. M.
Report of Investigations 8226r

Geology and methane content of the Upper Freeport coalbed in Fayette County, Pennsylvania, by P. F. Steidl.

Coal and overburden isopachs, structure and joint pattern maps, and a fence diagram were prepared using data from gas and oil exploration logs and coal outcrops. Free.

Report of Investigations 8247

Geology and gas content of coalbeds in vicinity of Bureau of Mines, Bruceton, Pennsylvania, by C. H. Elder.

Two degasification test boreholes were drilled to depths of 1,238 and 1,212 feet at Bruceton, Pennsylvania. The holes provided detailed geologic information and geologic sections. Free.

Order free U. S. Bureau of Mines publications from: Publications Distribution Branch, Bureau of Mines, Dept. of Interior, 4800 Forbes Ave., Pittsburgh, Pa. 15213.

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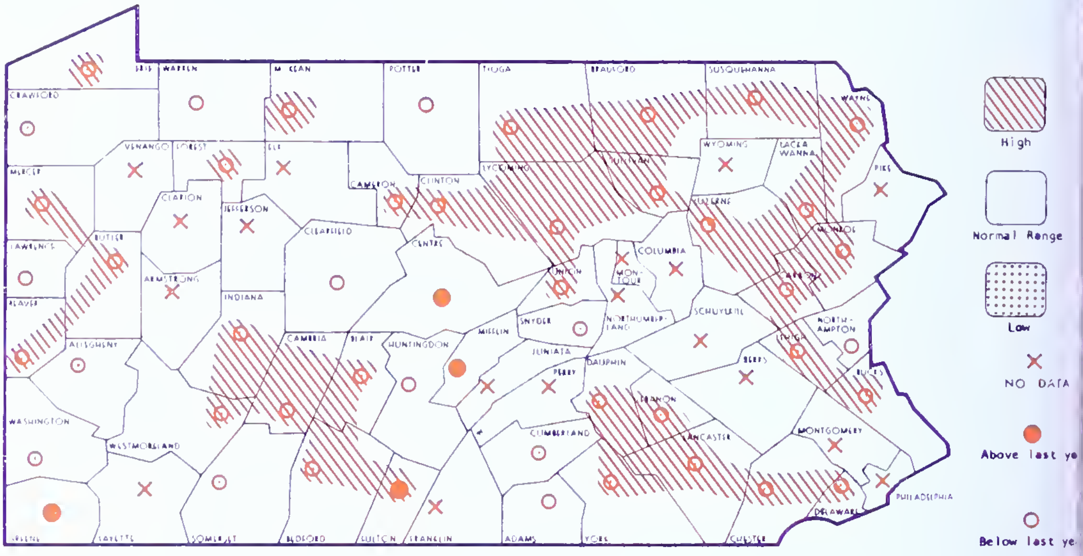

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ON THE COVER: Ice Age of 1978. View of ice jam pushed up along west shore of Susquehanna River, damaging homes and utilities at Long Level, south of Wrightsville, Pa. Photo courtesy of Peter Wilshusen.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

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APRIL 1978

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

ENERGY PROGRESS

In the midst of headlines on oil spills, coal strikes, nuclear protests, and increasing imports, it is comforting to find that some progress is being made here in Pennsylvania towards easing the energy situation.

Preliminary data for 1977 indicates that there has been a marked increase in drilling for natural gas in western and central Pennsylvania. This includes deep drilling by the major utilities, as well as shallow drilling by small industries seeking to establish an independent gas supply on their own company properties.

From southwestern Pennsylvania, particularly Greene County, comes news of advancing plans for some twelve major, new coal mines which will "tap" large "blocks" of previously untouched deep coal.

In central Pennsylvania the second unit of the Three Mile Island nuclear power plant on the Susquehanna River has been completed and is ready for operation. Further east, in Montgomery County, construction of the Limerick nuclear power plant is proceeding well, as is the Berwick nuclear power plant in Columbia County.

Noteworthy also are the reports that there are several investigations underway to see if some of the existing damned lakes in Pennsylvania can be adapted to also serve for hydropower electric generation.

Each of the above-mentioned new energy sources in Pennsylvania has utilized various aspects of our accumulated geologic data, such as coal bed structures and reserve calculations, oil and gas reservoir bed characteristics, and rock structure conditions of the various power plant and dam sites. We are pleased to note Pennsylvania's energy progress and the Pennsylvania Geological Survey is proud to be making its contribution to the effort.

Arthur A. Socolow

Exploratory Drilling in Pennsylvania Indicates Substantial Reserves of Natural Gas*

Karen Shumac[1]
Robert Piotrowski[2]

Amoco Production Company and UGI Development Corporation, whose gas utility division serves customers in eastern Pennsylvania, have begun an extensive exploratory drilling program in Pennsylvania. Seventeen to nineteen wells were programmed to be drilled over a 2-year period on an area of approximately 1,100,000 acres in 11 central and southwestern counties. UGI reportedly will invest up to $6 million in the program and get a 40% working interest in all wells to be drilled, plus the option to buy all natural gas found. Amoco is the operator of the program using outside turnkey contractors. Under the agreement, UGI also has the right to purchase gas from Amoco from production in the Shanksville field in Somerset County, discovered by Amoco in 1973; reserves are unofficially estimated at up to 27 billion cubic feet of gas.

Most of the wells were originally scheduled to be drilled in Somerset, Fayette, Westmoreland, and Centre Counties at depths ranging from 3,000 feet to 12,000 feet. These wells were to include tests of the Tuscarora (Silurian), the Oriskany (Lower Devonian), and Upper Devonian strata. The program began in May, 1977 and has, as of December, 1977,resulted in the drilling of 10 of the originally proposed wells with 2 additional 1977 locations postponed for drilling until 1978.

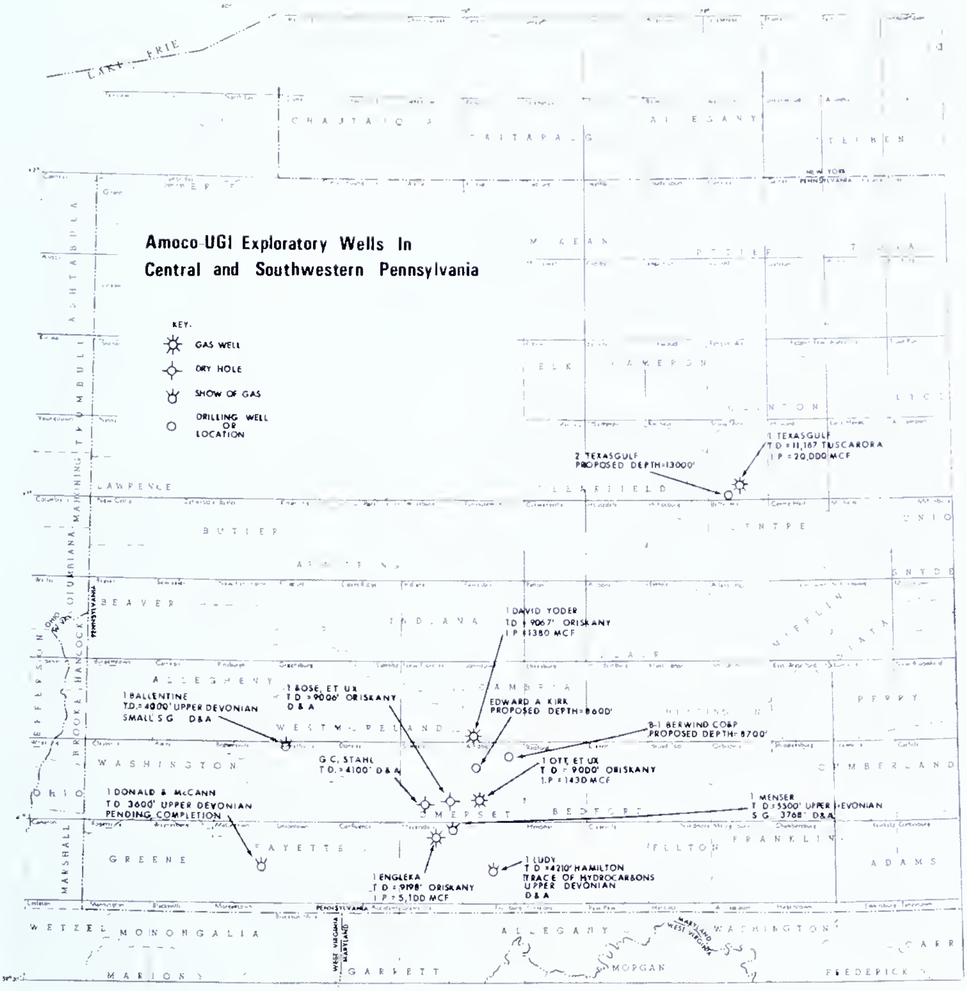
Of the Upper Devonian tests planned for the project, 5 are now completed. The first well of the program, #1 Ludy, located 8 miles southeast of the town of Berlin, Northampton Township, Berlin quadrangle, Somerset County, was started on May 4, 1977 and drilled to a depth of 4,210 feet to the top of the Hamilton Formation. A trace of hydrocarbons was found but not in commercial quantities, the #1 Ludy well was abandoned on May 19, 1977.

The George C. Stahl well, Somerset quadrangle, Somerset Township, Somerset County, was in operation from June 7, 1977 to

*(Adapted from February 20, 1978 Issue of Oil and Gas Journal)

[1] Student Intern, PA Geological Survey, Mercyhurst College, Erie, Pa.

[2] Staff Geologist, PA Geological Survey, Pittsburgh, Pa.


Amoco-UGI Exploratory Wells In Central and Southwestern Pennsylvania
KEY.
GAS WELL
DRY HOLE
SHOW OF GAS
DRILLING WELL OR LOCATION
1 TEXASGULF T D = 11,187 TUSCARORA I P = 20,000 MCF
2 TEXASGULF PROPOSED DEPTH=13000'
1 DAVID YODER TD = 9067' ORISKANY I P = 1380 MCF
1 BOSE, ET UX T D = 9006' ORISKANY D & A
1 BALLENTINE T.D.= 4000' UPPER DEVONIAN SMALL S G D & A
EDWARD A KIRK PROPOSED DEPTH=8600'
B-1 BERWIND CORP PROPOSED DEPTH= 8700'
G C, STAHL T D. = 4100' D & A
1 OTT, ET UX T D = 9000' ORISKANY I.P = 1430 MCF
1 DONALD & McCANN T D 3600' UPPER DEVONIAN PENDING COMPLETION
1 MENSER T D = 5500' UPPER DEVONIAN S G 3768' D & A
1 ENGLEKA T D = 9198' ORISKANY I P = 5,100 MCF
1 LUDY T D = 4210' HAMILTON TRACE OF HYDROCARBONS UPPER DEVONIAN D & A
LAKE ERIE
CHAUTAUQUA
CATTARAUGUS
ALLEGANY
STEUBEN
NEW YORK
PENNSYLVANIA
ERIE
MC KEAN
POTTER
TIOGA
ELK
CAMERON
CLINTON
LYCOMING
LAWRENCE
CLEARFIELD
CENTRE
UNION
BUTLER
ARMSTRONG
SNYDER
BEAVER
INDIANA
MIFFLIN
JUNIATA
BLAIR
ALLEGHENY
CAMBRIA
HUNTINGDON
PERRY
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WASHINGTON
CUMBERLAND
SOMERSET
BEDFORD
FRANKLIN
FULTON
FAYETTE
GREENE
ADAMS
OHIO
ASHTABULA
TRUMBULL
MAHONING
COLUMBIANA
JEFFERSON
HANCOCK
BROOKE
MARSHALL
WETZEL
MONONGALIA
MARION
WEST VIRGINIA
MARYLAND
GARRETT
ALLEGANY
MORGAN
WASHINGTON
FREDERICK
CARROLL

June 19, 1977. It was drilled to a depth of 4,100 feet and abandoned with no show of gas to this depth.

The Menser #1 well, located 3-½ miles southeast of Somerset, Somerset Township, Meyersdale quadrangle, Somerset County, started drilling operations on June 9, 1977. There was a show of gas at 3,768 feet, but the well was abandoned as a dry hole at 5,500 feet on July 11, 1977.

The Ballentine #1, located 2 miles northeast of Hutchison, Connellsville quadrangle, Sewickley Township, Westmoreland County, was plugged and abandoned at 4,000 feet in August, 1977 after various well developed Upper Devonian reservoir zones were found to be predominantly water bearing; only small gas shows were encountered.

The Donald R. McCall #1 well, located 2 miles northwest of Smithfield, Masontown quadrangle, Nicholson Township, Fayette

County, was drilled to a total depth of 3,600 feet and is temporarily shut in, pending completion. Shows of gas were encountered from the Balltown, Speechley, and shallow Upper Devonian zones. During the year, Amoco and UGI initiated an Upper Devonian farmout program to increase exploration for economic Upper Devonian gas reserves.

Four Oriskany tests have been drilled and 2 more have scheduled locations. The #1 David Yoder well, Johnstown quadrangle, Conemaugh Township, Somerset County, started on July 16, 1977 was successfully completed October 19, 1977. The initial potential of this discovery is reported to be calculated absolute open flow of 1,380,000 cubic feet per day. The #1 Yoder is drilled to a depth of 9,067 feet with pipe set at 9,055 feet. The Yoder discovery, opening Heckman Hollow field, is 2 miles southwest of the city of Johnstown.

The #1 Ott well, Windber quadrangle, Paint Township, Somerset County, flowed gas at an estimated rate of 275,000 cubic feet per day while drilling the Oriskany; total depth is 8,895 feet. The #1 Ott well was completed on November 16, 1977, and is 4-½ miles southwest of the town of Windber. The initial potential of this discovery is reported to be 1,430,000 cubic feet of gas per day after hydraulic fracturing.

A flow of 5,100,000 cubic feet of gas per day after drilling was reported at #1 Engleka, Jr., Meyersdale quadrangle, Somerset Township, Somerset County. The drilling was started on September 11, 1977 and continued until reaching a total depth of 9,198 feet.

A completed Oriskany test at #1 Rose, 9 miles southwest of the city of Johnstown, Somerset quadrangle, Jenners Township, Somerset County showed no signs of production. Drilling of the Rose well started on October 13, 1977 and reached a total depth of 9,006 feet.

Other scheduled Oriskany tests include two in Somerset County, the B-1 Berwind Corp. and the Edward A. Kirk. The Berwind B-1 well, Windber quandrangle, Shade Township, is scheduled for a depth of 8,700 feet, and the Kirk #1 well, Windber quadrangle, Stoneycreek Township, for a depth of 8,600 feet.

The most successful well in the program started July 17, 1977 in Centre County and has gained much attention. The Texasgulf, Inc. Tract 1, Snowshoe quadrangle, Boggs Township, encountered a visually estimated flow of 20,000,000 cubic feet of gas per day in an open hole test at 10,760 feet in the Tuscarora Formation. The apparent discovery is 8 miles northwest of the town of Bellefonte and 27 miles south of the Leidy gas storage field where production was from the Oriskany. The nearest production from Silurian is 110 miles to the west-northwest in Venango County's Irwin gas pool, where the Clinton Formation is producing. Futher details have not been released by the operators. Amoco and UGI have staked a second well 1/2 mile southwest of the first. The #2 Texasgulf is scheduled to Tuscarora at about 13,000 feet.

Of the 19 originally scheduled wells to be drilled by Amoco and UGI in Pennsylvania, 10 have been drilled. Four of these 10 wells have been successful with flow rates ranging between 1,380,000 cubic feet per day to 20,000,000 cubic feet per day of natural gas. A completion decision is pending for a fifth, Upper Devonian, well. Three of the 4 producers in the project are in Somerset County, but the most promising so far has been #1 Texasgulf in Centre County. Additional testing has been postponed until 1978, and after this time UGI has the option to extend the program for 3 separate one-year periods by contributing $2 million per year for additional seismic studies and exploratory drilling. The success of the Amoco-UGI program thus far, in particular the promise of the Texasgulf well, has shown that Pennsylvania has excellent gas production potential. Due to the demand and rising price of natural gas, exploratory drilling in Pennsylvania is expected to increase.

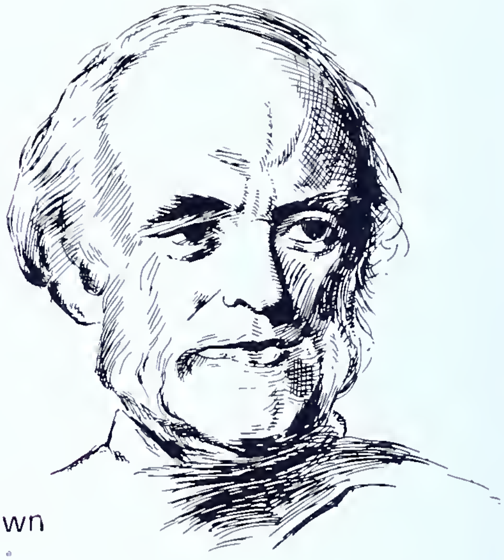
A Chall

The U. S. Geological Survey has developed a "tote board" which compares past material consumption in the U. S. with anticipated future mineral consumption. The comparative figures for several major commodities were given as follows:

	Total U.S. Consumption over the past 200 yrs. (1776-1977)	Anticipated U. S. Consumption during the next 45 yrs. (1978-2023)
Iron	3.2 billion tons	5.5 trillion cubic meters
Copper	77 million tons	186 million tons
Sand & gravel	30.7 billion tons	91 billion tons
Mineral fuels (oil, gas, coal)	450 billion barrels	1083 billion barrels
Water	19.7 trillion cubic meters	36 trillion cubic meters

In every case the anticipated consumption for the next 45 years far exceeds the combined use over the past 200 years. Thus, geologists and the mineral industry have their work cut out for them if they are to meet the challenge of the anticipated needs of our society.

Charles Lyell and Pennsylvania



by William R. Brice
Associate Professor
Earth & Planetary Sciences
University of Pittsburgh at Johnstown

Charles Lyell (1799-1875), the great British geologist, mentor and friend of Charles Darwin, is well known to most geologists in this country for his book, *Principles of Geology* which helped turn geology into a unified science. However, it is not well known that Lyell made four visits to our continent; the first lasting from July 1841 till August 1842, and the second from September 1845 to June 1846 were the longest of his visits. The third was a short visit from August through November, 1852, and his last trip to these shores was for two months in 1853 when Lyell represented the British government at the New York Industrial Exhibition (Bailey, 1963).

After each of the first two extended visits Lyell published his observations and experiences, both geological and personal; *Travels in North America in the Years 1841-2* (1845) and *A Second Visit to the United States of North America* (1849). In both of these are to be found delightful, thought provoking, and amusing descriptions of life in these United States as Lyell found it in the middle of the 19th century.

Although his travels carried him and his wife from Nova Scotia to the Mississippi delta, it is his contact with the state of Pennsylvania that is of importance here. His first trip here was via Corning, New York. Lyell had been traveling in New York State with James Hall who took his leave at Geneseo. From there Lyell travelled by coach in which "...our coachman seemed to take pleasure in driving rapidly over deep ruts and the roughest grounds...," (Lyell, 1845, v. I, p. 46). On September 7 he reached the coal fields of Blossburg (which Lyell spelled Blossberg). Here he was conducted through the area by the president of the local mine, Dr. Saynisch, who told him of shooting wolves from his bedroom window, and of a panther killed on the outskirts of Blossburg. However, Dr. Saynisch suggested Lyell shouldn't worry too much for ". . .the bears have not been seen in years." (Lyell, 1849, v. I, p. 51).

After Lyell had examined the coals and related rocks he was struck by the similarity which existed between coal measures in Pennsylvania and their European counterparts. Also, he was able to find the plant fossil *Stigmaria* in growth position in the underclay associated with the coal seams, which suggested to him that coal originated from plants growing on the spot. The same relationship of coal and *Stigmaria* had been noted in Wales as well.

After this short excursion into Pennsylvania, Lyell returned to New York and went to Albany. From Albany, after several side trips with James Hall, Lyell travelled by steamer on the Hudson to New York City, and then by railway to Philadelphia. There he found "the streets of Philadelphia rival the finest Dutch towns in cleanliness. . . ." (Lyell, 1845, v. I, p. 61). His stay in this fair city was not altogether a restful one, however, for every night for the five day stay ". . .there was an alarm of fire, usually a false one;. . ." (op. cit. p. 61). It all caused Lyell to comment, "they manage these matters as effectively at Boston without turmoil." (op. cit. p. 61).

From Philadelphia Lyell spent several days travelling in New Jersey with T. A. Conrad. Professor H. D. Rogers, of the first Pennsylvania Geologic Survey, met Lyell on October 3rd for a trip into the anthracite region. The party travelled up the Schuylkill River for a while over the gneissic rocks, then on up to Reading, and eventually to the town of Pottsville, ". . .a flourishing manufacturing town with the tall chimneys of numerous furnaces, burning night and day, yet quite free of smoke." (op. cit. p. 67).

In the neighborhood of Pottsville, Lyell found 13 seams of anthracite, ". . .several of which are more than two yards thick." (op cit. p. 67) He was also quite taken with what we refer to today as the Pottsville conglomerate, "a conglomerate of coarser texture than I had ever seen in any productive coal-measures, some pebbles of quartz being of the size of a hen's egg." (op. cit. p. 68) He found the *Stigmaria* associated with the coal here as well, together with what he refers to as the "British species" of *Pecopteris lonchitica* and *Neuropteris cordata.* At the Lehigh Summit Mine, he discovered that several of the coal seams ran together to form a single unit about 50 feet thick. At "Mauch Chunk, or the Bear Mountain" he found an early strip mine, ". . .this remarkable bed of anthracite is quarried in the open air,. . ., the summit of the hill being 'scalped' as one of the miners expressed it." (op. cit. p. 69).

Apparently Sir Charles (as he was to become in 1848) was more than slightly skeptical as to the suggested thicknesses for some of the rock units in Pennsylvania. "I at first supposed that some deception might have arisen respecting the alleged thickness of the older fossiliferous rocks of the Appalachians,. . ." (op. cit. p. 70). But he was soon convinced ". . .that those Silurian and Devonian strata, which do not exceed in their aggregate thickness a mile and half in the State of New York, acquire more than three times that thickness in the Pennsylvania Alleghanies." (op. cit. p. 70).

Comparison of the fossils associated with the anthracite coal in the Pottsville area with what he had seen associated with the bituminous at Blossburg also convinced Lyell that the coal measures were indeed of the same age. In this he supported the idea put forth in 1831 by G. W. Featherstonhaugh. Lyell was quick to grasp the connection between the existence of the anthracite and the association of disturbed strata.

After leaving Pennsylvania in October of 1841, Lyell travelled from Boston to Charleston before returning to the state in January 1842. He was then to remain in Philadelphia until March of that year. This time his major problem was one of currency rather than geology. His dollar notes were not as sound as he had hoped. Paper money then was backed by banks, not the federal government, and if the bank folded, so did the value of the paper. Fortunately Lyell converted his paper money to gold less than four weeks before the four banks on which his money had been issued failed.

Even the Governor of Pennsylvania had his problems with the paper money of the day. He had come to Philadelphia because state funds being held for a debt payment were in a bank which failed a few days before payment was to be made. To make matters worse, no other bank in Philadelphia would advance the state the money to pay its bond debt.

Lyell spent the next few months in New England, and then came back to Pennsylvania from Frostburg, Maryland, passing General Braddock's grave, and following the roads of his disastrous march to Fort Duquesne and Pittsburgh, which Lyell spelled "Pittsburg." Along this route he travelled over ". . .Laurel Hill, so called from its rhododendrons. . ." (Lyell, 1845, v. II, p. 20) near the town of Union, ". . .its site being marked by a thin cloud of smoke,. . ." (op. cit. p. 20). Lyell was struck by being able to cross a great natural barrier, and find people on the other side speaking the same language, with the same customs and political institutions. This was unlike what he had experienced in Europe.

From Union(town) the party went to Brownsville on the Monongahela River. The one thing that greatly impressed Lyell now that he was on the plateau was "...the richness of the seams of coal..." (op. cit. p. 22.) At Brownsville he describes an outcropping of the "Pittsburg" seam ten feet thick. Mines and mine openings dotted the river banks; thus taking advantage of the natural exposure. Lyell was able to follow this seam "...the whole way to Pittsburg, fifty miles distant." (op. cit. p. 25). He quotes the brothers Rogers as saying the coal fields on the plateau (including Virginia and Ohio) as covering "...fourteen thousand square miles."

On May 15, 1842, Lyell and his wife embarked at Brownsville for "Pittsburg." Their means of conveyance was a long, narrow, single-paddle steamer. From a bend in the river, "...we had a fine view of Pittsburg, partially concealed by the smoke of its numerous factories." (op. cit. p. 27). He described the city as "...a most flourishing town, and we counted twenty-two large steamboats anchored off the wharfs." (op. cit. p. 27). The same large coal seam was exposed in the hillsides, and also down near the river's edge was a small seam over which he found layers of shale and limestone with *Bellerophon, Leptaena* and *Spirifer,* just as he had seen a few days earlier at Frostburg, Maryland.

Not all trips run smoothly, and Lyell's was no exception. "The steamboats on the Ohio cannot be depended upon for punctual departure at the appointed hour like those of the Hudson or Delaware." (op. cit. p. 28). Because of this, he went by public coach to Wheeling where he hoped for better luck with the boats. Travelling towards Wheeling, Lyell noted the absence of "drift and boulders" which he had seen in great abundance in the north. However, what started unpleasantly was destined to become vexatious.

"On reaching one of those ennumerable towns to which, as if for the sake of confusion, the name of Washington has been given, I received the agreeable intelligence that, instead of travelling to Wheeling before sunset, I must wait till another mail came up in the middle of the night." (op. cit. p. 28). Thus with that somewhat sour note, on May 15, 1842, Charles Lyell and his wife took their leave of Pennsylvania.

During his second trip to the United States about three years later, Lyell did not spend much time in Pennsylvania. He stopped at Philadelphia in December of 1845 on his way to the south. The major topic of the day then was politics and not geology; the Oregon question, the state income tax which was "...weighing heavily on

Pennsylvania. . . ." (Lyell, 1849, v. I, p. 193). He found many Philadelphians had taken houses in New Jersey to escape the tax, but ". . .resorting in the winter season to Philadelphia for the sake of society." (op. cit. p. 193).

After a trip through the south, up the Mississippi and the Ohio, the Lyells arrived in "Pittsburg" (still with no "h") from Cincinnati; noting that the punctuality of the steamers was better this time than in 1842. On April 16, 1846, they approached Pittsburgh, in what appears to have been a typical Pennsylvania spring. "There had been so hard a frost in the night, that the roof of our steamer's cabin was glazed with a thin sheet of ice. . ." (Lyell, 1849, v. II, p. 225). He notes how well the city has recovered from a great fire between his visits. Lyell claims that Pittsburgh ". . .has every advantage save that of an atmosphere free from coal smoke." (op. cit. p. 225). Labor strikes and unrest were common then. "I learnt that there had recently been a strike of the factory girls here for ten instead of 12 hours of daily labor." (op. cit. p. 225).

The stay in Pittsburgh was brief, for the object of his visit was to see a set of fossil footprints at Greensburg. Through East Liberty, Wilkinsburg, and Adamsburg they travelled, stopping occasionally to look at coal outcrops. Greensburg was a town of about 1000 inhabitants, with five churches and three newspapers. A Dr. King conducted him to the quarry in Union township, six miles southeast of Greensburg, on the farm of Mr. Gallagher. Unfortunately, the original slab had crumbled, but Dr. King had made a set of casts which Lyell examined. The footprints had been found in a sandstone approximately one hundred feet below the Pittsburgh coal. They were associated with *Lepidodendron, Sigillaria* and *Stigmaria* both above and below. Lyell identified the prints as that of a reptile similar to the European cheirotherium. He calculated that other footprints found in the area had been sculptured by the local Indians.

On April 10, 1846, Lyell and his wife left Greensburg by stagecoach for Philadelphia. It seems that misfortune and Pennsylvania were synonymous for Lyell. On this journey, by night, two different coaches broke wheels due to the poor condition of parts of the road. (Too many potholes perhaps.) No journey would be complete without some misplaced luggage, and one of three bags was left behind after a night transfer to a new coach. After writing to three places to claim it, five days later the bag rather mysteriously appeared in his hotel room in Philadelphia and no one knew who brought it, or how it got there. Despite broken wheels and late departures, Lyell had high praise for public conveyances in the U. S. Not once did he ever loose a package, even including some 30 boxes of geological specimens which were shipped, for all of them sooner or later were delivered to his door in London.

The first dawn of his journey from Greensburg came as the coach topped Laurel Ridge where the dense morning fog hung like lakes in the small valleys below. The coach travelled along the Juniata River for a while; eventually it reached Chambersburg where the Lyells, after a night's rest, transferred to a train and continued the journey at the "rate of fourteen miles per hour." This cross-state journey was to be Lyell's last direct contact with Pennsylvania. Although he did return to the U. S. on two other occasions, these were short visits and he had little time for geological activity.

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Water Resource Film Available

A color sound motion picture on water resource investigations has been produced for the U. S. Geological Survey and is now available for public viewing. The 28-minute film explains how the USGS appraises the quantity, quality, distribution, and occurrence of surface and ground water.

The film focuses on how the USGS monitors and evaluates water resources through a nationwide hydrologic network, and how such data and research are used by local, state, and federal agencies to help solve a wide range of complex water problems. The subjects discussed include techniques for monitoring and analyzing water supplies, droughts, floodmapping, underground waste disposal problems, water use and consumption, and the need for water to meet a variety of industrial, domestic, and agricultural demands.

The film, titled "The Subject is Water," may be obtained on loan for viewing by contacting the U. S. Geological Survey's Branch of Visual Services, 303 National Center, Reston, Va. 22092.

Triassic-Jurassic Diabase Dike At Hellam, York County, Pennsylvania

by Jon D. Inners and J. Peter Wilshusen

Recent field investigations for an environmental geology study of the York metropolitan area have resulted in the discovery of a small Triassic-Jurassic diabase dike at Hellam, York County, Pennsylvania. The dike trends north-northeast and crosscuts lower Paleozoic rocks in the York Valley synclinorium of the Piedmont Province. Because of its narrow width, short length, and lack of topographic expression, the dike had not been detected by the geologists who had previously mapped the area (Stose and Jonas, 1933; 1939). Local landowners, however, have long recognized it as a band of "ironstone" crossing their properties.

The Hellam dike has an exposed length of about 2.25 miles and trends mainly N20E, changing toward N0E at the apparent north end (Figure 1). The southern limit of the dike is well defined about 1.0 mile west of Valley View Park and 1.1 miles south of Hellam Borough, but the north end is concealed by colluvium and dense woods on the south edge of the Hellam Hills. Rock formations intruded by the dike range from the Lower Cambrian Antietam quartzite to the Middle (?) Ordovician Conestoga limestone.

The best exposure of the Hellam dike is at Clayton Ely Emig Park on the north bank of Kreutz Creek (40°00'02"N/76°36'13"W, Columbia West 7 1/2-minute quadrangle) (Figure 2). There the dike is about 25 feet thick (as determined by a magnetometer traverse), although only 15 feet in the center of the dike are exposed. It dips about 75° toward N70W and intrudes basal limestone conglomerate of the Conestoga Formation. A small amount of float from the dike is present at the east end of a road cut in the Vintage dolomite on U. S. Route 30, about 0.25 mile north of Hellam Borough (40° 00'40"N/76°35'56"W, Columbia West 7 1/2-minute quadrangle). The thickness and orientation of the dike at this locality cannot be accurately determined.

The dike rock is a very tough, dark-gray, fine to medium grained, equigranular diabase of the York-Haven type (Smith and others, 1975). At Emig Park, the outcropping ledges are moderately jointed, with individual joints spaced mostly 6 inches to 1 foot apart; the most prominent joint set strikes N73W and dips 75° northeast. On weathering, diabase joint blocks develop a distinctive orangish-

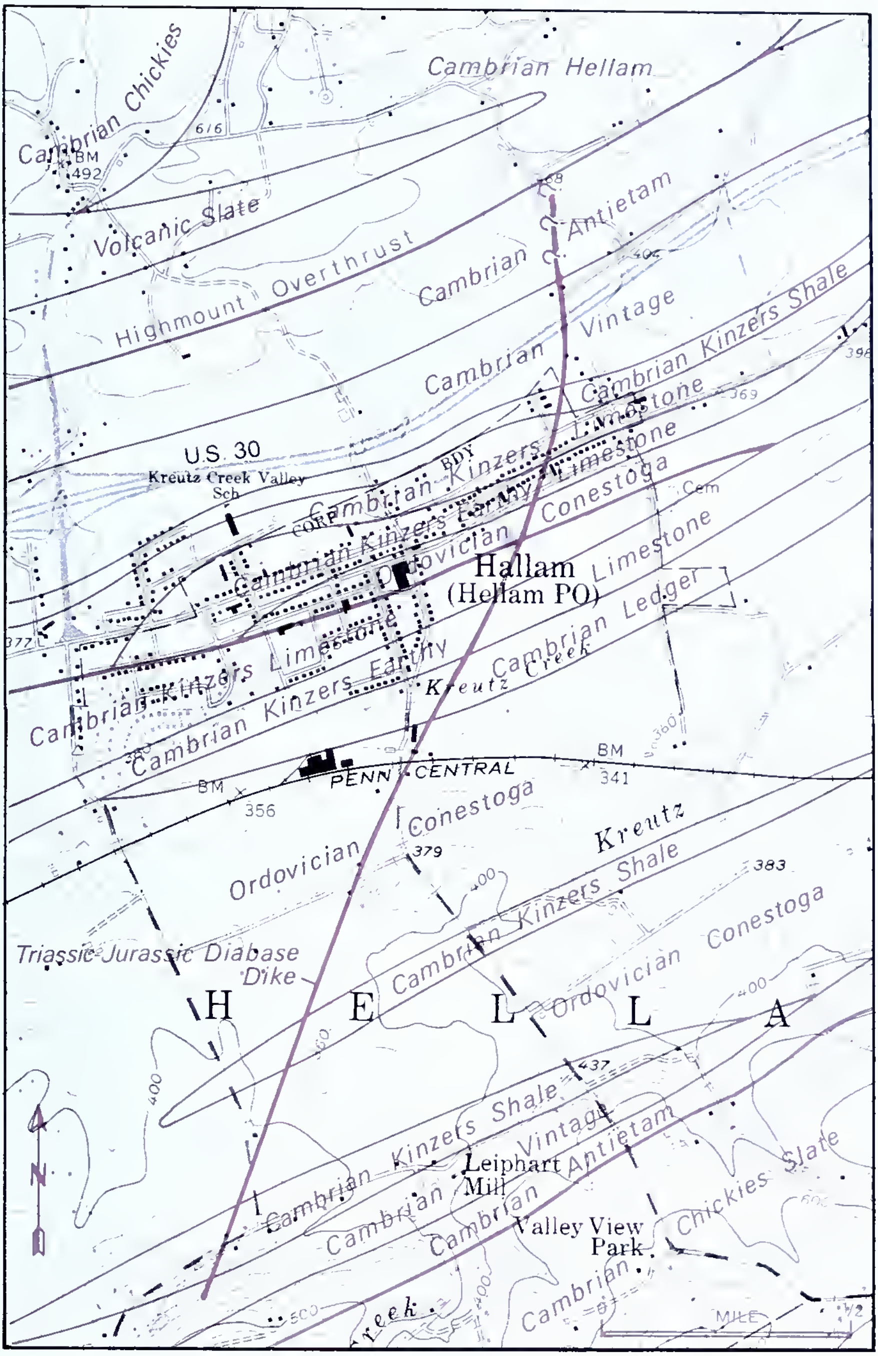

Figure 1. Geologic map of portions of Columbia West and Red Lion 7 1/2-minute quadrangles, York County, showing outcrop trace of Hellam dike. (Contacts of Paleozoic formations from Stose and Jonas, 1939, Plate 1).

brown rind, 1 to 2 mm thick, and exfoliate in thin sheets. Soil formed from the dike rock is stony, orange-brown, and clay-rich;

subrounded to subangular cobble- and pebble-size fragments of partially weathered diabase are common. These "stony patches" along the trace of the dike are minor annoyances to local farmers.

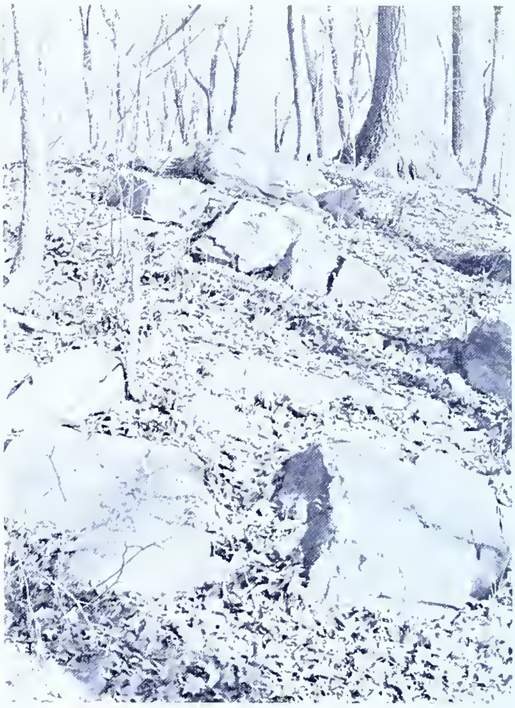

Figure 2. Exposure of Hellam dike at Clayton Ely Emig Park, Hellam. Note well-developed joints along which diabase is broken into angular blocks. Looking north-northeast along strike of dike; dip is steeply to left (northwest). White ruler is 12 inches (30cm) long.

In thin section (Figure 3), diabase from the middle of the dike at Emig Park is composed predominantly of laths of plagioclase and subhedral grains of pyroxene that range in size from 0.1 to 1.0 mm, averaging 0.25 to 0.5 mm. Texture is subophitic, and primary alteration is moderate. Mineral percentages are as follows (determined by a point count of 200 grains):

Plagioclase (laboradorite $An_{56\pm4}$)	40 percent
Pyroxene (mostly augite)	41 percent
Opaque oxides (ilmenite and magnetite)	5 percent
Sericite (alteration product of plagioclase)	10 percent
Chlorite (alteration product of pyroxene	4 percent
Biotite	trace
Apatite (needles in plagioclase)	trace
	100 percent

The mineralogy of this sample reflects a late stage in the differentiation and crystallization of the dike; a sample from the chilled margin would be more representative of the chemical composition of the original magma.

Plagioclase grains commonly exhibit slight zoning; augite is often twinned, and a few grains have cores of an earlier, altered pyroxene. The presence of mica (biotite and sericite) and chlorite were confirmed by X-ray powder diffraction analysis (Smith, oral communication).

The Hellam dike is one of several thin diabase intrusions of Late Triassic or Early Jurassic age that cut across the York Valley and the

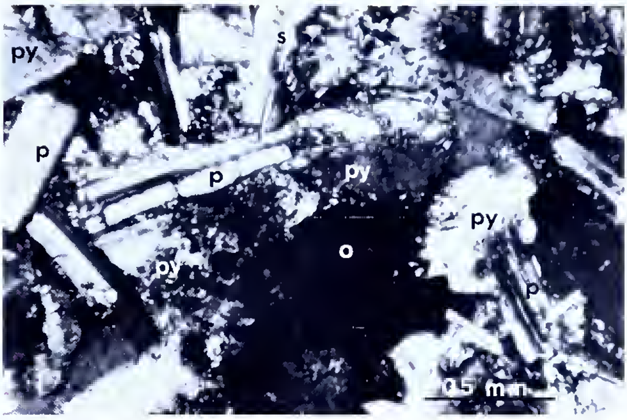

Figure 3. Photomicrograph of medium grained diabase from center of Hellam dike at Emig Park (p=plagioclase; s=sericite; py=pyroxene; cn=chlorite; o=opaque).

adjacent Lancaster Valley to the east. The two nearest dikes, both of which are roughly parallel to, but considerably longer than the Hellam dike, are the Stonybrook dike, located 2.0 miles to the west of Hellam, and the Safe Harbor dike, 14 miles to the east. The Stonybrook dike is Rossville-type diabase and the Safe Harbor is York Haven-type (Smith and others, 1975). The Hellam dike itself lies approximately on the same trend as a diabase dike of uncertain type that was mapped by Stose and Jonas (1933) on the north side of the Susquehanna River east of Maytown and Donegal Springs, Lancaster County. If the "Maytown" dike extends to the south bank of the Susquehanna, some diabase should be evident in the excellent exposures of Chickies quartzite near Wildcat Falls on the north side of the Hellam Hills, about 2.0 miles east of Accomac. The fact that neither Stose and Jonas (1933) nor Wilshusen found any trace of diabase at this locality indicates that the "Maytown" dike terminates on the north bank of the Susquehanna. Thus, even if the Hellam dike does continue for some distance north of the termination mapped on Figure 1, it is unlikely that it cuts completely across the Cambrian quartzites of the Hellam Hills and continues northward as the "Maytown" dike. A significant gap, or offset, between the two dikes is probable.

The writers thank Robert C. Smith II for assisting with the petrographic identification of minerals and for performing an X-ray diffraction scan of a powdered sample of diabase. Paul Ebersole led Inners to several float crops of the dike in cultivated fields near Hellam.

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SURVEY ANNOUNCEMENTS

GLACIAL BORDER MAPPING ON OPEN FILE

A report on the Late Wisconsinan glacial border in eastern Pennsylvania and its accompanying maps have been placed on open file at the Pennsylvania Geological Survey in Harrisburg. This report comprises maps at scale 1:100,000 on topographic base which show the trace of the Late Wisonsinan glacial border from the Delaware River, near Belvidere, north-westward to Bullis Mills on the New York border. Various types of glacial drift are mapped for about one mile north of the glacial border and older drift materials are noted in the area for about one mile south of the border. The report discusses the general nature, age and economic significance of the glacial materials and gives a detailed description of the length of the border. The original compilation sheets at scale 1:24,000 are also on open file. This report and maps, authored by G. H. Crowl and W. D. Sevon, provides new insight into the maximum extent of the last glaciation in Pennsylvania and some information about economically important sands and gravels. These materials may be examined in the offices of the Pennsylvania Geological Survey, Executive House, 101 S. Second Street, Harrisburg, Pennsylvania, 17101, but are not in a form suitable for reproduction.

MAP OF UNCONSOLIDATED SURFICIAL MATERIALS

A generalized surficial geology map of Pennsylvania has been compiled at a scale of 1:250,000 by W. D. Sevon and is now on open file at the Pennsylvania Geological Survey in Harrisburg. The several map sheets delineate 25 different surficial materials including spoil piles, rock ridges with colluvium slopes, Late Wisconsin till, Illinoian till and mixed sedimentary rocks, and mixed hard and soft sedimentary rocks with landslide deposits. The intent of the map is to indicate generally, what types of unconsolidated materials occur at the surface throughout Pennsylvania. An accompanying explanation presents a brief description of the nature of the mapped materials. These maps may be examined in the offices of the Pennsylvania Geological Survey, Executive House, 101 S. Second Street, Harrisburg, Pennsylvania 17101, but are not in a form suitable for reproduction.

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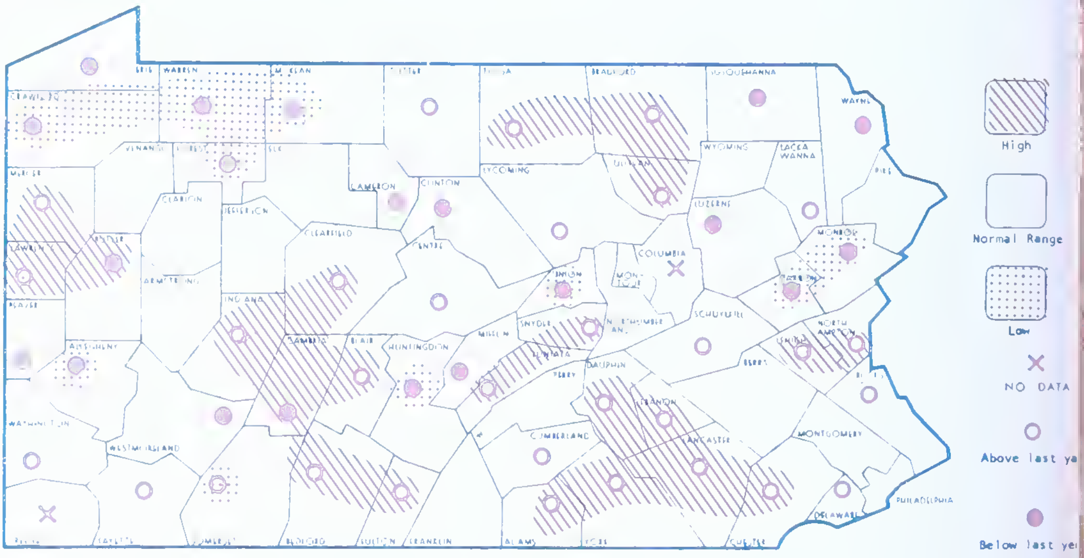

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ON THE COVER: Typical Pike County bluestone (flagstone) prospect near Kimble: a small outcrop of planar-stratified sandstone.

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JUNE 1978

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

COMPETITION - FOR WORSE OR BETTER

We have grown up in an era in which we have been taught that competition is desirable, even essential, to sustain our economic way of life and to provide incentives for greater achievements as man (person) strives to outdo man (person).

Around our great Commonwealth, our bountiful nation, and amongst many countries of the world there is a form of competition going on which has tremendous impact on all our lives and particularly on the lives of future generations. It is the competition for the use of land.

Land use competition is fostered by various forces which differ from place to place, and vary in intensity with time. In one area the impetus is created by urban and suburban expansion. In another locale, growing or relocating industry is the active ingredient. Elsewhere it is the recognized need for agricultural acreage, for transportation facilities, for forestry tracts, or for mineral lands. Our environmental awakening has given primary status to the land needs for protecting our watersheds, sustaining wilderness areas and preserving natural and historical wonders.

This competition for land has resulted on many occasions in bitter and acrimonious struggles. Decisions are more often than not based on economic or political leverage. Emotion frequently wins the day, rather than analysis and reason. As many of these land competition conflicts go to court, victory is very likely to go to those who best know, or best can afford, the legal maneuvers.

Bases for decisions have been also determined by what is currently in vogue; in the past dams, highway corridors, levees, shopping centers were favored, often to the detriment of other considerations. Today, there are other favored land uses which receive preferential treatment, which is not necessarily well evaluated. Conversely, there are proposed uses which are categorically in disfavor, according to the temper of the times, regardless of how beneficial the proposed use might be.

We definitely need a sound procedure to deal effectively with the competition for land. It must be a procedure which evaluates all aspects of each problem area, both short range and long range. It must recognize and even quantify where possible, the competing needs and the multiple resources of the land area. It must consider such aspects as uniqueness and irreplaceability, and the needs of the ecosystem, not forgetting the needs of man himself. A system for resolving competition for land will have to develop broad and innovative perspectives, and will have to deal with concepts such as highest order of use, and wherever appropriate, multiple land use.

(Continued on page 11)

Arthur A. Socolow

Bluestone in Pike County, Pennsylvania

by W. D. Sevon

INTRODUCTION In 1886 the Kilgour Blue-Stone Company, Ltd., headquartered at Parkers Glen, Pike County, Pennsylvania (Figure 1), operated 23 bluestone quarries and employed 450 men (Mathews, 1886). The Kilgour stonemills at Parkers Glen operated 24 hours a day sawing, planing and polishing bluestone for all types of building purposes, particularly flagstone. The Kilgour Company was only one of several then active in Pike County.

As the 19th century ended, Portland cement began to replace natural stone as a construction material. A peak of bluestone production in 1912 was followed by rapid decline with only minimal production by 1932 (Stone, 1923; 1932). Now, in 1978, only one man in Pike County quarries bluestone on a part-time basis.

It is not known whether the bluestone industry will revive in Pike County, but an abundance of high-quality rock is available. The purpose of this paper is to discuss the attributes of these rocks and the potential for renewed production.

STRATIGRAPHY Quality bluestone in Pike County occurs in the lower part of the Catskill Formation and is restricted mainly to a unit originally named the Delaware River flags (White, 1882). Some bluestone was quarried from slightly lower and higher stratigraphic positions. Name changes were introduced by Willard and others (1939) and Fletcher and Woodrow (1970), but the interval remains as White defined it: a thick sequence of gray sandstones occurring above the first thin red beds of the Catskill, and below a thick sequence of red beds. White (1882) calculated this unit's thickness at 1430 feet. The stratigraphic terminology used in Figure 1 is that of Fletcher and Woodrow (1970) and Berg (1975).

FIELD OCCURRENCE Pike County bluestone is derived from the lower, planar-stratified part of three similar types of vertical sequence. *Sequence 1* comprises planar-stratified, gray sandstones grading upward into finer-grained, cross-stratified sandstones. The lowest cross-strata are generally very low-angle, tabular cross-strata. Successive sets of cross-strata have higher-angle, tabular or trough

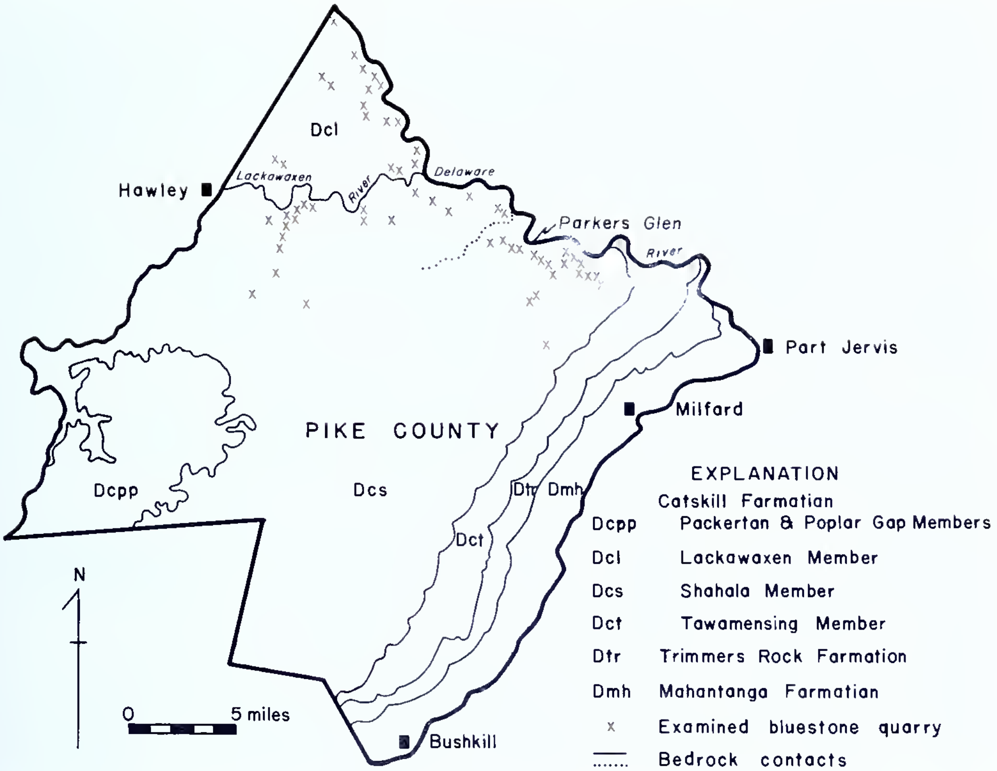

Fig. 1 Geologic map of Pike County, Pennsylvania.

cross-strata and erosional bases. Sandstones above disconformities are often coarser grained than the underlying sandstones. Poorly sorted calcareous breccias containing small dark-gray shale fragments and calcareous nodules, some rounded quartz pebbles and occasional plant fragments occur occasionally at the bases of cross-strata sets. In *Sequence 2,* the planar-stratified, gray sandstones are separated by a pronounced disconformity from overlying coarser grained, trough cross-stratified sandstones (Figure 2). In *Sequence 3,* planar-stratified, gray sandstones grade up into tabular or trough cross-stratified sandstones which in turn grade up into planar-stratified sandstones followed by red siltstones and claystones. *Sequences 1* and *2* occur with about equal frequency; *Sequence 3* is uncommon. The three sequences possess an apparently random vertical stacking.

The planar-stratified sandstones often appear structureless in fresh outcrop, but they possess distinct lamination with spacing of a few millimeters or less and sometimes barely detectable reactivation surfaces. Parting into flaggy pieces one or more centimeters thick occurs along these laminae. Some bedding surfaces display primary current lineation (ties) and parting-step lineation. Many surfaces contain abundant mica flakes and some surfaces show finely broken

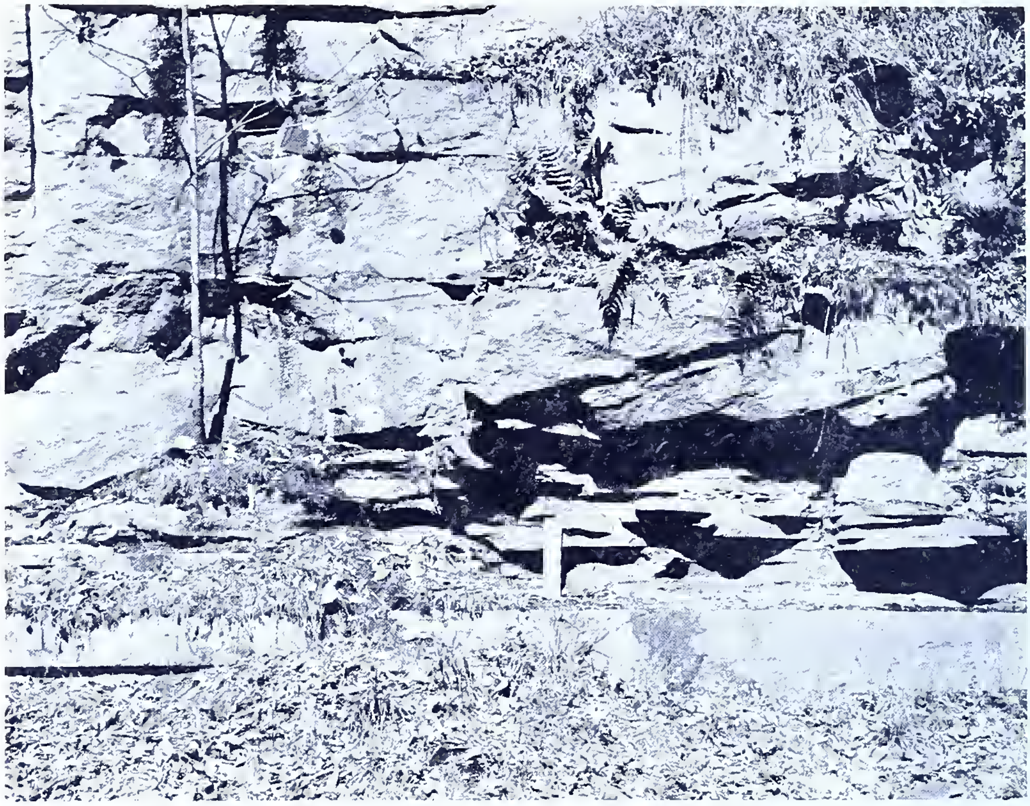

Fig. 2 Typical Sequence 2.

plant fragments. Ripple bedding is noticeably lacking in both the planar- and cross-stratified sandstones. These sequences are frequently less than 10 feet thick, but sometimes are up to 30 feet thick.

Some planar-stratified units appear to be continuous for several hundred feet parallel with the orientation of parting lineation. Continuity normal to parting lineation appears to be less, and the planar-strata are apparently replaced laterally by cross-strata. Cross-stratified sandstones are more abundant, but apparently have more limited lateral continuity than the planar-stratified units.

Pike County bluestone is a well-indurated, fine-grained (average grain size: 0.1 mm), medium-gray sandstone averaging 62 percent framework and 38 percent binder. The average sandstone comprises: 48 percent undulose quartz and 22 percent sericite-chlorite composite matrix; small percentages of silica overgrowth, microcrystalline silica cement, shale clasts, feldspar, coarse micas, chlorite matrix, calcite cement and metamorphic rock fragments; and traces of polycrystalline quartz, limonite cement, chert, stretched metaquartz, heavy minerals (mainly zircon) and siltstone clasts. Binding is generally very good within individual laminae where silica cement is the main binder and poorer between laminae where sometimes sericite-chlorite matrix is the only binder. Grains are almost always angular and alignment of grain long axes parallel to lamination is common. Lamination is a function of variation in grain size, concentrations of heavy minerals or shale clasts, concentrations of mica, and variations in binding agents. Some chloritization of the clay matrix has occurred in all of the sandstones.

ORIGIN The various features of Pike County bluestone are best explained by deposition in a braided stream system. The planar stratification developed by sand deposition on longitudinal bars under upper flow regime conditions of floods. The thiner planar-stratified units may represent deposition during a single flood, but thicker units with reactivation surfaces between successive planar strata probably resulted from multiple depositional events. Trough cross-stratification is attributable to dune migration and tabular cross-stratification derives from downstream migration of sand waves and transverse bars. Continued aggradation combined with channel shifting and downstream migration of various bedforms resulted in considerable lateral and vertical variation within the bluestone interval. The few red siltstones and claystones were presumably deposited by flood waters in protected areas adjacent to the active braided stream. The input stream derived from an eastern source and entered into Pike County somewhere near Port Jervis, New York (Burtner, 1964).

ECONOMIC GEOLOGY Bluestone is a dense, hard, fine-grained, feldspathic sandstone which splits easily along bedding planes into smooth slabs of various thicknesses. These slabs are used for flagging, tread, veneer, coping, sill, wallstone, slab stock, hearthstones and mantles. The greatest use is for flagging (Mikutowicz and Schenck, 1970a). Although the market is not large, a continuing demand for good quality bluestone still exists, and Pike County formerly produced some of the best.

Commencing a quarry operation in Pike County at this time would be an economic venture of some uncertainty. Consideration should therefore be given to market adequacy, the competitive existence of a bluestone industry in nearby Susquehanna County (Mikutowicz and Schenck, 1970a; Krajewski and Williams, 1971) and some of the potential directions suggested for industry improvement in Susquehanna County (Mikutowicz and Schenck, 1970b).

The location of the bluestone quarries in Pike County (Figure 1) was originally influenced by (1) proximity to transportation facilities along the Delaware and Lackawaxen Rivers and (2) the ease of locating quarryable rock on the outcrop-abundant steep slopes adjacent to these rivers (cover photo). Although sandstone suitable for quarrying exists to the southwest within the same stratigraphic unit, slopes are less steep, outcrops are less abundant and prospecting for suitable bluestone is more difficult.

Many of the 92 inactive quarries examined contain sufficient planar-stratified sandstone for additional quarrying and all of the quarries have large waste piles of rejected rock which has some potential as a source of crushed rock and random-sized flagging (Figure 3). Two problems are apparent in some of the larger quarries. First, because most of the quarries are located on hillsides and the bluestone is mined into the hillside, over-burden thickness increases and becomes a hinderance to profitable operation. Second, as quarrying proceeds into a hillside, the bluestone becomes fresher and can be split only into thicker and thicker pieces. This limits the use diversity and may have been a factor in closing some quarries. Because the ease with which bluestone splits parallel to its laminae is dependent on the degree of adhesion between laminae, the development of planes of splitting ease (rifts) apparently results from decreased adhesion caused by weathering and time-related pressure-

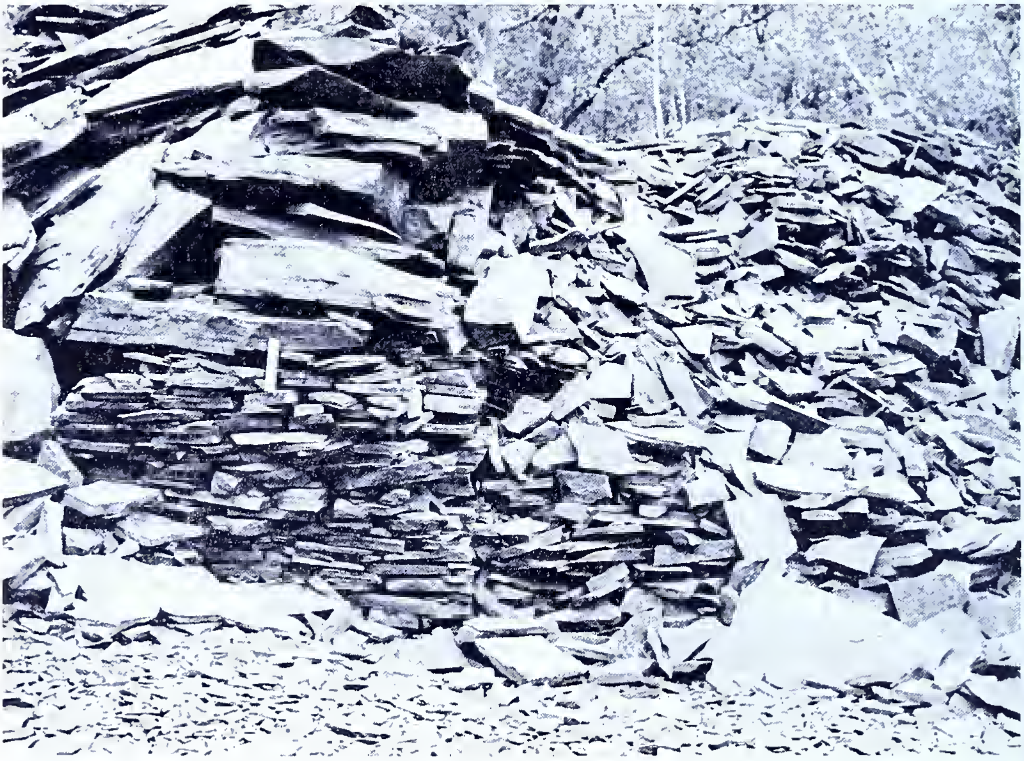

Fig. 3 Bluestone waste pile

release following removal of overburden. As quarrying proceeds and fresher rock is mined, the bluestone apparently splits only along the weakest planes (reeds) which represent significant changes in texture or mineralogy.

Joints, which aid quarrying and also limit stone size, are well developed in Pike County and generally have a spacing of 10 feet or more, although irregularly spaced and oriented joints (cutters) are not uncommon.

Excellent quality bluestone awaits future development in Pike County. Although quarrying bluestone involves much hand operation, new and improved cutting and drilling equipment can greatly assist quarry operation. Almost all of the existing quarries once had road access which could be reestablished with moderate ease. Knowledge of the relationship between parting lineation and continuity of planar-stratification should allow quarry development in the direction of greatest bluestone persistence.

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Field Conference Of Pennsylvania Geologists To Meet In Northeastern Pennsylvania

The 1978 Field Conference of Pennsylvania Geologists will meet in northeastern Pennsylvania to examine Upper Paleozoic rocks bearing uranium minerals. Headquarters for the conference will be in the Hazleton area with one day planned to visit outcrops along the Lehigh Valley and a second day planned to visit outcrops in the Beaver Lake area along the boundary of Lycoming and Sullivan counties. The Pennsylvania Geological Survey, The Pennsylvania State University, and industrial representatives will serve as hosts and guides to the various rock exposures. To receive the final announcement and registration form for the conference, write to the Field Conference of Pennsylvania Geologists, c/o Pennsylvania Geological Survey, P.O. Box 2357, Harrisburg, PA 17120.

The Story Of The Susquehanna River

Dr. Lee E. Boyer, lecturer Emeritus of Mathematics at Harrisburg Area Community College, as a lifetime student of Pennsylvania's natural history, has written a fascinating and informative report entitled, *"On the Susquehanna River: Its Evolution and its Antics"*. Dr. Boyer presents the river as one of those characters you are not likely to forget.

A limited number of copies of the 30 page booklet *"On the Susquehanna River: Its Evolution and its Antics"* are available for $2.00 (to cover publication and mailing) from Dr. Lee E. Boyer, 1508 Pelham Road, Harrisburg, PA 17110.

Nickeloan Pyroaurite Verified From The Cedar Hill Quarry, Lancaster County, Pennsylvania

by Robert B. Finkelman and Patricia A. Estep-Barnes

Davis M. Lapham (1965) suggested that a yellow-green powdery coating on serpentinite surfaces at the Cedar Hill Quarry in Lancaster County, Pennsylvania, might be a nickeliferous magnesium (carbonate?) hydroxide. He noted the similarity between the Cedar Hill mineral and pyroaurite $[Mg_6 Fe_2^{3+}(OH)_{16}CO_3 \cdot 4H_2O]$, but, primarily because he observed no positive reaction for carbonate, concluded that the Cedar Hill mineral was an hydroxide, and was related to pyroaurite (Lapham and Geyer, 1972). Lapham (1965; personal communication, 1974) however, acknowledged that the fine-grained, impure nature of this material made identification difficult.

In the present effort to better characterize Lapham's mineral, the following samples were studied: Lapham's type material from the National Museum of Natural History (NMNH 120215); specimens of serpentinite with yellow-green to pistachio-green coatings collected (by RBF) at the Cedar Hill Quarry; samples supplied by

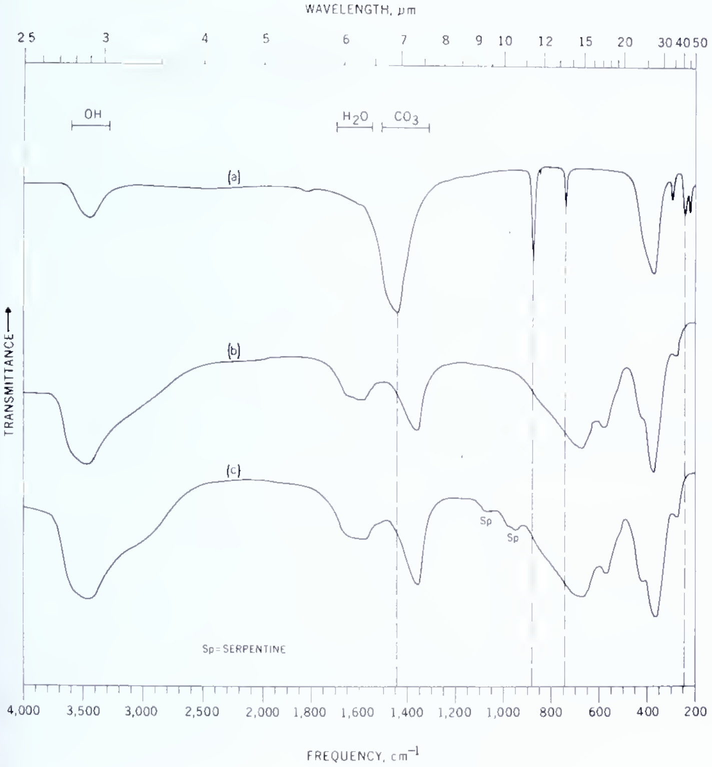


Fig. 1. A scanning electron photomicrograph of the nickeloan pyroaurite crystals from the Cedar Hill quarry.

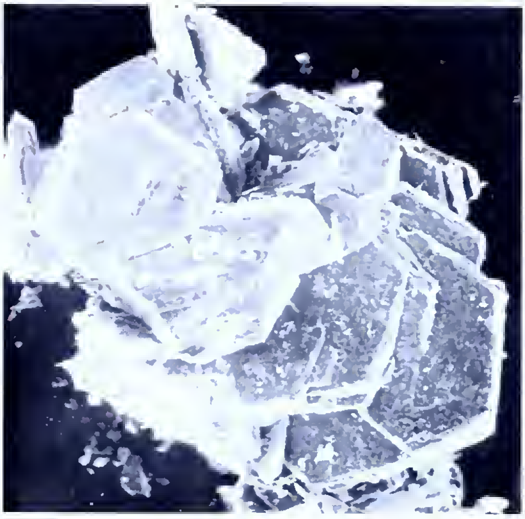
the Pennsylvania Geological Survey, which may contain the original material studied by Lapham (destruction of the Survey headquarters in Harrisburg by the flood following tropical storm Agnes in 1972 makes verification difficult); a specimen from the quarry loaned by Martin L. Anné of Wrightsville, Pennsylvania, containing white to green, 1 mm diameter, hexagonal crystals (Fig. 1); nickeloan pyroaurite from San Benito County, California, (NMNH 121644) in which Ni^{2+} has replaced some Mg^{2+} in the pyroaurite structure; and pyroaurite from Sterling Hill, New Jersey, (NMNH R16652) and Långban, Sweden (NMNH 10688).

The optical properties and X-ray powder data for all the samples studied were virtually identical to those described by Lapham (1965) for the Cedar Hill mineral. However, microinfrared analysis (Estep and others, 1973) of Lapham's type material (NMNH 120215) gave a spectrum similar to that of pyroaurite (Figure 2). Strong absorption bands characteristic of a hydrated basic carbonate were present which clearly differentiate Lapham's mineral from the admixed simple carbonates such as dolomite and magnesite. Furthermore, the low-frequency absorption band (365 cm^{-1}) was intermediate between the corresponding bands for the Långban pryoaurite (370 cm^{-1}) and the California nickeloan pyroaurite (360 cm^{-1}), suggesting minor variations in cation substitution. This is consistent with the energy dispersive microprobe analysis which indicated a lower nickel content of the Cedar Hill material relative to the California nickeloan pyroaurite. In addition to variable amounts of nickel, all samples contain major magnesium and iron, and several had detectable silicon, probably due to admixed serpentine. As Lapham (1965) suggested, the darker green crystals appear to contain more nickel.

Lapham's conclusion that carbonate was not an essential constituent of the Cedar Hill mineral was based largely on the absence of effervescence in 1.0 normal hydrochloric acid (HCl). Although all of the samples examined in the course of this study dissolved in 1.0 normal HCl, effervescence was not always readily apparent. In concentrated HCl, however, all samples effervesced vigorously.

From the present study it is concluded that the pale green encrustations on serpentinites in the Cedar Hill Quarry are predominantly nickel-bearing pyroaurite, identical in every respect to the nickeloan pyroaurite described by Wilson and others (1976) from Scotland. The nickeliferous magnesium (carbonate?) hydroxide described by Lapham (1965) is, without question, nickeloan pyroaurite.

Fig. 2. Infrared spectra of (a) magnesite (San Bernadino Co., California) (b) pyroaurite (Sweden: NMNH 10688) (c) nickeloan pyroaurite (Pennsylvania: NMNH 120215)



Acknowledgments

The advice and encouragement of the late Davis M. Lapham was invaluable in this study.

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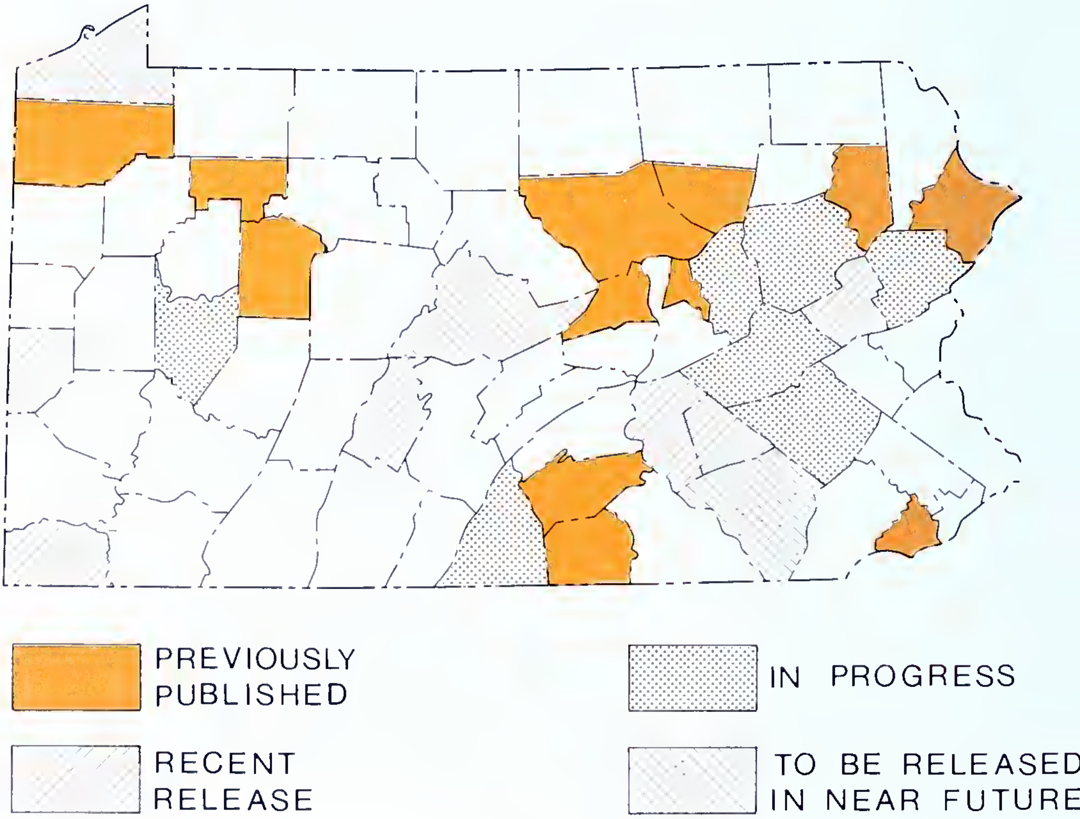
(Continued from page 1)

Past experience has demonstrated that at best in this one area of competition, for the use of land, the results have not always been in the best interest of mankind--or for the physical and biological earth itself. It is urgent that we get on to a better procedure, replacing emotion, leverage, and ignorance, with facts, analysis, and creative, long-range decisions.

U.S. GEOLOGICAL SURVEY ISSUES NEW COUNTY TOPOGRAPHIC MAPS

As a product of the cooperative county mapping program with the Pennsylvania Geological Survey, the U.S. Geological Survey has recently issued new topographic maps of Beaver, Blair, Carbon, Dauphin, Greene, and Lebanon counties. These new maps are at a scale of 1:50,000 (approximately 4000 feet to the inch) and follow the previously issued maps of Adams, Crawford, Cumberland, Delaware, Forest, Jefferson, Lackawanna, Lycoming, Montour, Pike, Sullivan, and Union counties. Soon to be released are maps of Centre, Erie, and Lancaster counties. These maps are multicolored, following the standard colors of topographic maps, with the addition of political boundaries for county, township and boroughs outlined in orange. These county maps are of widespread use to all who are concerned with county and regional planning, engineering, agricultural, and recreational projects. These maps may be obtained for $2.00 each by writing to Distribution Section, U.S. Geological Survey, 1200 S. Eads Street, Arlington, VA 22202.



SURVEY ANNOUNCEMENTS

CHANGE IN FIELD DIVISION LEADERSHIP

Dr. Samuel Root has resigned from the Pennsylvania Geological Survey to take on a position with the Exxon Corporation as a senior exploration geologist, to be based in Rio de Janeiro, Brazil. Sam Root was with the Pennsylvania Survey for 15 years, serving nearly the entire time as Chief of the Geologic Mapping Division. During that period the division achieved an outstanding record of geologic mapping and reports which are widely acclaimed for their professional qualities. Dr. Root himself established a national reputation for his work on Appalachian structural interpretations. The staff of the Pennsylvania Geological Survey extends best wishes to Sam Root.

Succeeding Sam Root as Chief of the Geologic Mapping Division is Thomas Berg. Tom joined the Pennsylvania Geological Survey in 1965 after receiving his B.A. and M.A. degrees in geology from the University of Colorado. He has worked on geologic mapping projects in a variety of geologic settings in Pennsylvania. These have included coal-bearing formations of western Pennsylvania and the Devonian-age formations of northeastern Pennsylvania, along with the glacial deposits of the region. Most recently Tom Berg has headed up the Survey team working on the compilation of a new state geologic map.

We are fortunate to have Tom Berg to take on the duties of Chief of the Geologic Mapping Division. Basic geologic mapping continues to be the foundation upon which all other geologic interpretations and applied aspects are dependent. The Pennsylvania Geological Survey aims to carry on with its assigned task of systematically mapping the geology of Pennsylvania in detail.

PENNSYLVANIA SURVEY'S BEST SELLERS FOR 1977

"Mineral Collecting in Pennsylvania", Pennsylvania Geological Survey Bulletin G-33, was the top seller, with report G-40, "Fossil Collecting in Pennsylvania", a close second. Information on caves was very popular with reports G-67, G-66, and G-65 constituting our third, fourth, and seventh most popular reports. Interest in bituminous coal continues high with our report M-6, Part 1, M-6, Part 2, and M-68 in the top ten sellers. Oil and gas developments were also of interest with our report PR-189 in fifth place. York County and Fayette County geology and mineral resources were also of interest, as was the general geology report of the Pittsburgh area, our report G-59. The most popular map continues to be Map 1, Geologic Map of Pennsylvania; number two was the map of the coal fields of Pennsylvania, our Map 2. All cost publications issued by the Pennsylvania Geological Survey are sold through the State Book Store, P.O. Box 1365, Harrisburg, PA 17125.

MONROE COUNTY LOCALITY CLOSED TO FOSSIL COLLECTORS

The *Pocono Record* of Stroudsburg recently reported that the "CENTERFIELD CORAL REEF" locality on Pa. Route 191 has been removed from public access by its owners, the Pinebrook Junior College. Large "private property" and "no trespass" signs were painted on the rock face.

This locality is one of the most prolific and famous localities of Devonian corals of many genera and species. Several scientific research articles have been written on the fossils from this locality.

This fossil occurrence was listed as Locality 43 in the book, "Fossil Collecting in Pennsylvania", Bulletin G-40 of the Pennsylvania Geological Survey. Future editions of this booklet will include other localities in Monroe County suitable for fossil collectors, now that the "Centerfield Coral Reef" locality is no longer accessible to interested collectors.

MAPS OF THE DEVONIAN ORGANIC RICH SHALES AND SANDSTONES IN THE SUBSURFACE OF WESTERN PENNSYLVANIA ARE OPEN FILED

The Bureau of Topographic and Geologic Survey, in cooperation with the U. S. Department of Energy (contract EY-76-S-05-5198), is investigating regional geologic and stratigraphic information on the Middle and Upper Devonian clastic rocks in the subsurface of western Pennsylvania. This study is a portion of the resource characterization phase of the Eastern Gas Shale Project with emphasis placed on the stratigraphy and regional geology of the Devonian organic rich black shales. With permission of the D.O.E., we are placing on open file nine stratigraphic cross sections which indicate the major black shale units and sandstones in the Middle and Upper Devonian, as well as a series of three maps at a scale of 1:250,000 which will show: (1) all wells which penetrate the Middle Devonian Onondaga Limestone and indicate which of these have gas shows or gas production from the Devonian black shales; (2) a contoured Drilling Depth Map to the top of the Onondaga Limestone; and (3) a Structure Contour Map on the top of the Onondaga Limestone. In addition, a series of maps at a scale of 1:1,000,000 will show the distribution and thickness of the major black shale units and sandstones defined on the stratigraphic cross sections mentioned previously.

At this time, four of the nine stratigraphic cross sections, the Onondaga Penetration and Devonian shale gas show map at a scale of 1:250,000, and the Drilling Depth Map to the top of the Onondaga Limestone at a scale of 1:250,000, are available. The remaining cross sections and maps will be available when completed.

This material is available for examination at the offices listed below and copies of the maps and cross sections will be made available at the expense of the requestor. Pennsylvania Geological Survey, 1201 Kossman Building, 100 Forbes Avenue, Pittsburgh, PA 15222; Morgantown Energy Research Center, U.S. Department of Energy, Eastern Gas Shale Prcject, P.O. Box 880, Morgantown, W.VA 26505.

Coal-The Burning Question

by Jeanne Sonntag

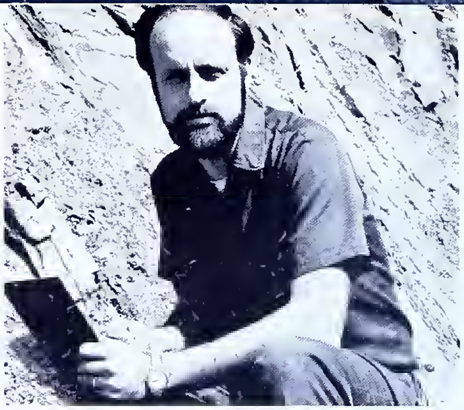
The League of Women Voters of Pennsylvania using a grant made by Pennsylvania Power and Light Company to the League of Women Voters Education Fund has recently published a twenty-page booklet entitled, ''Coal—The Burning Question''.

The slim publication offers an unbiased and comprehensive citizen's view of the Pennsylvania coal industry. It discusses the impact of such considerations as economics, transportation, research and development, the environment, unions, and health and safety on the coal industry. The booklet also contains tables on methods of removing sulfur from coal, new technologies for coal use and combustion as well as a list of publications for further reading.

The twelve-month study was conducted by thirteen volunteer League members from all parts of the Commonwealth and a small staff based in Harrisburg. The group, called PACT, Pennsylvanians Assess Coal Today, was divided into a western task force to study the bituminous industry and an eastern group to concentrate on anthracite mining. The PACT teams visited universities, coal research facilities, reclamation areas, strip mines and deep mining operations. Extensive interviews were held and contacts made with mine owners and operators, unions, mining engineers, miners, and government representatives.

The free publication may be obtained by writing to League of Women Voters of Pennsylvania, 215 Pine Street, Harrisburg, PA 17101.

Meet The Staff . . .



Thomas M. Berg, Chief
Geologic Mapping Division

Thomas M. Berg joined the Pennsylvania Survey in 1965. Tom has been a member of the Geologic Mapping Division since then, and has completed several Atlas Reports involving detailed geologic mapping in west-central and northeastern Pennsylvania. In addition to his mapping work in the coal-bearing rocks of the western part of the state, Tom participated in the early organization of the Survey's ongoing bituminous coal sampling program. In 1970, he began detailed mapping in Carbon, Monroe, and Pike Counties. This work involved deciphering Middle and Upper Devonian strata, as well as glacial and periglacial deposits.

In 1975, Tom was promoted to the position of senior research geologist, and was assigned the job of coordinating the compilation of a new state geologic map, the fifth such map assembled since 1858. The state map project is now nearing completion.

On April 24, 1978, Tom was appointed to the position of Chief of the Geologic Mapping Division. His responsibilities include planning, supervising, and coordinating basic geologic mapping projects by staff geologists throughout the Commonwealth, as well as steering the activities of the geologists assigned to bituminous coal studies. In addition to his duties as a division chief, Tom continues to oversee the Survey's fossil collection, and answers questions of a paleontological nature.

Tom was born in Vermillion, South Dakota, and obtained his B.A. and M.S. degrees in geology from the University of Colorado in Boulder, Colorado. He spent a large part of his youth in the Washington, D.C. area, and did part of his undergraduate work at Johns Hopkins University in Baltimore. He is a member of the Harrisburg Area Geological Society, the Society of Economic Paleontologists and Mineralogists, and the International Paleontological Association.

Tom, his wife Betty, and their five children reside in Dauphin, Pennsylvania, just north of Harrisburg. He is quite active in his church at Dauphin, where he serves on the executive board and is coordinator of religious education. In addition to his normal family activities, one of Tom's favorite pastimes is a visit to the shore, where he can observe and marvel at the marine invertebrates that live and function in so many similar ways as did the fossils that he finds in Pennsylvania's rocks.

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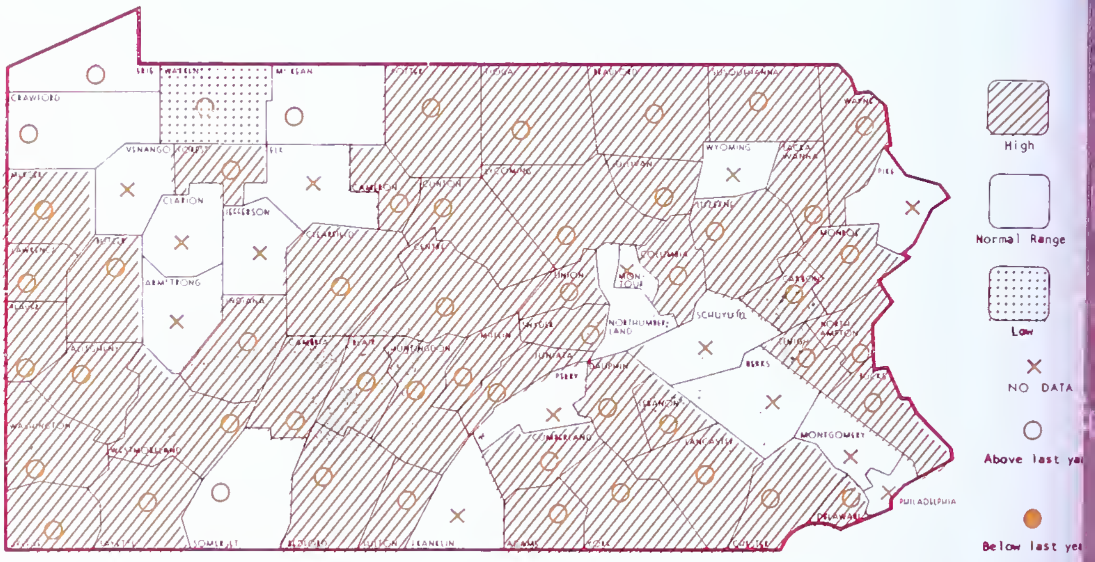

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ON THE COVER: Modern hieroglyphics on the Old Red Sandstone: wall of small quarry in the Catskill Formation along Pennsylvania Route 402, north of Peck's Pond, Pike County. Photo courtesy of William H. Bolles.

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Articles may be reprinted from this magazine if credit is given to the Topographic and Geologic Survey.

AUGUST 1978

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

GROUNDWATER COMES OF AGE

A number of recent developments on the national, state, and local level have demonstrated that there is now widespread recognition that consideration must be given to protect and manage our subsurface or groundwater resources. It wasn't always so, particularly here in the east. Emphasis in the past was on the visible surface waters. Groundwater was out of sight, and, thus, out of mind. On a regional basis it was underused, while in many places the groundwater was badly misused.

Now, awareness and help is coming from many other quarters. The Delaware River Basin Commission recognized the importance of groundwater management many years ago and specified that proposed new, high-yield water wells would have to have prior approval and permitting. Now the Susquehanna River Basin Commission has taken similar steps.

In Washington the U.S. Office of Surface Mining, created by the new federal coal strip mine act, is designating specific requirements that will protect groundwater from undue quality and quantity impacts by coal strip mines.

In those areas of Pennsylvania where many new deep coal mines are being planned in response to our energy needs, it is noteworthy that county and town officials are specifically requesting that government agencies, as well as company representatives, look into the question of the impact of the proposed deep coal mines upon the groundwater resources of the respective areas.

With the growing and widespread use of irrigation techniques amongst our farmers across the Commonwealth, more and more have turned to the use of wells and groundwater and these people also are also expressing great interest in sound groundwater management.

The Pennsylvania Geological Survey has for over 50 years been delineating the occurrence, and touting the importance, of the subsurface water of the Commonwealth. We welcome the growing awareness of groundwater importance and we recognize the need for responsible groundwater management procedures. To that end we shall continue to assemble and analyze the basic data on groundwater and related geologic conditions upon which sound water management decisions can be made.

Arthur A. Socolow

GEOLOGICAL RESEARCH IN PENNSYLVANIA

1978

INTRODUCTION

This publication is the twenty first annual report on Geological Research and Publications in Pennsylvania. This is an attempt to list all current geologic research in Pennsylvania and includes persons and projects other than those of the Pennsylvania Geological Survey. Because of the extensive response and large number of projects reported to us, we have had to exercise editorial license to reduce the description of the research projects to fit our available space. We have also attempted to determine an anticipated completion date (ACD) for each project. The anticipated completion date is the estimate of the date when the author will complete his report; additional time for publication should be projected.

The listings are grouped into major categories of research to facilitate your search for information on a particular subject. Publications in press are listed by author.

As with all compilations, there may be omissions; this is unintentional. Additional copies of this report may be obtained by writing to the Bureau of Topographic and Geologic Survey, Department of Environmental Resources, P. O. Box 2357, Harrisburg, Pennsylvania 17120.

RESEARCH IN PROGRESS

AREAL GEOLOGY

T. M. BERG, A. A. SOCOLOW, D. M. HOSKINS, A. R. GEYER, Pa. Geol. Survey, S. I. ROOT, Esso Productions, W. E. EDMUNDS, Consultant, D. B. MacLACHLAN, W. D. SEVON, and A. D. GLOVER, Pa. Geol. Survey. Revision of Pennsylvania State Geologic Map. Compilation maps for the revision have been released to open file and may be examined at the Survey's headquarters in Harrisburg. Remaining work to be done includes drafting and editing. Publication scheduled for mid-1979.

M. J. BERGIN, U.S. Geol. Survey. Northern Anthracite Field, Pa. Work in current year will consist of geologic map compilation for Kingston, Pittston, and Wilkes-Barre West quadrangles. Studies will continue on distribution, stratigraphy, and structure of Mississippian and Devonian rocks surrounding the Northern Anthracite field to determine regional correlations and relationships to Southern, Western-Middle, and Eastern-Middle Anthracite fields. ACD: Indefinite.

HERBERT BLODGET, NASA, and GREGORY SMITH, DAVID O'HARA and WILLIAM BRAGONIER, R & P Coal Company. Potential Use of Remote Sensing for Mine Roof Stability Studies [Indiana and Armstrong Cos., Pa.] A cooperative project between NASA and R & P Coal to determine if remote sensing techniques can be used to predict mining conditions and patterns of sedimentation. ACD: Oct. 1978.

G. W. COLTON, U.S. Geol. Survey. Bedrock Geology of the Jersey Shore Quadrangle. ACD: 1978.

C. H. DODGE, U.S. Geol. Survey. Reconnaissance Mapping in Northwestern Pa. Reconnaissance mapping (compiled at 1:24,000) is underway in Elk, southeastern Forest, northern Jefferson, and southern McKean Counties. Work to date has concentrated on field investigations and subsurface data collection. Study will include bedrock geologic maps and cross sections. ACD: 1980.

J. B. EPSTEIN, U.S. Geol. Survey. Geology of the Wind Gap Quadrangle. ACD: 1978.

R. T. FAILL, A. D. GLOVER, and J. H. WAY, Pa. Geol. Survey. Geology and Mineral Resources of the Altoona 15' Quadrangle, Blair, Cambria, Centre, and Clearfield Cos., Pa. Mapping of bedrock units from Cambrian to Pennsylvanian in age, surficial units (alluvium, colluvium), structures in the Valley and Ridge province and Allegheny Plateau province, with discussions of economic deposits (primarily coal), engineering properties, and environmental characteristics. ACD: 1979.

LOUIS HEYMAN, Pa. Geol. Survey. The Subcrop Beneath the Onondaga-Huntersville-Bois Blanc Formations in the Subsurface of Western Pa. The above units overlie, with increasing unconformity, rocks from Lower Devonian to the south to Upper Silurian to the north. The subcrop pattern may delineate otherwise concealed, deeper structure and hydrocarbon traps. ACD: 1979.

J. D. INNERS, Pa. Geol. Survey. Geology and Mineral Resources of the Bloomsburg and Mifflinville Quads., Columbia Co., Pa. ACD: 1980.

D. B. MacLACHLAN, Pa. Geol. Survey. Geology and Mineral Resources of the Reading and Birdsboro Quads., Berks Co., Pa.

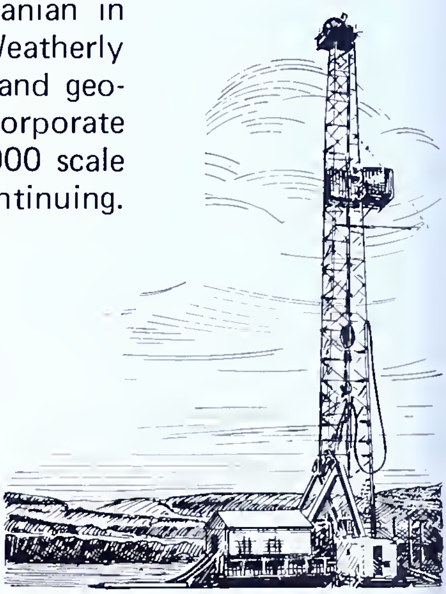
H. W. SCHASSE, Pa. Geol. Survey/The Pa. State Univ., and A. W. ROSE, The Pa. State Univ. The Geology and Mineral Deposits of Jacks Mountain in the Mount Union and Butler Knob 7½-Minute Quads., Central Pa. Detailed geologic map and cross sections (1: 24,000), structural interpretations, map of mineral localities. Sphalerite and galena occur in Silurian Tuscarora Formation along tension fractures and joints and as breccia fillings along transverse macroscopic faults. ACD: June 1978.

W. D. SEVON, T. M. BERG, Pa. Geol. Survey, and L. SCHULTZ, Gilbert Commonwealth, Inc. Geology and Mineral Resources of Pike Co., Pa. Report will include separate bedrock and surficial geologic maps at scale 1:50,000 and an accompanying text. ACD: 1978.

J. H. WAY, Pa. Geol. Survey. Geology and Mineral Resources of the Washingtonville and Millville Quads., Montour, Columbia, and Northumberland Cos., Pa. Project includes the geologic mapping of bedrock and surficial deposits, defining and sampling materials with possible economic potential, and describing environmental and engineering characteristics of all geologic units in the area. ACD: 1980.

G. H. WOOD, JR., U.S. Geol. Survey. Southern Anthracite Field. Continue to study, report, and produce information about stratigraphy, structure, depositional-erosional history, and resources of rocks ranging from Silurian to Pennsylvanian in age. Work is presently being done in Weatherly 7½-minute quadrangle. Compile mining and geologic data and, with resource studies, incorporate into geologic quadrangle maps at 1:24,000 scale and coal maps at 1:12,000 scale. ACD: Continuing.

ECONOMIC GEOLOGY



T. M. BERG, A. D. GLOVER, M. A. SHOLES, V. M. SKEMA, and H. W. SCHASSE, Pa. Geol. Survey. Coal Resources of Greene and Washington Cos., Pa. Data currently in Survey files and all new data that can be obtained on the rocks in Greene and Washington Counties are being prepared for computer entry under the National Coal Resource Data System (NCRDS). ACD: Apr. 1979.

J. A. COMET, Oil City, Pa., W. S. LEEPER, L. S. BEERS, and J. L. BLUM, National Fuel Gas. Reinterpretation of Seismic Data [NW Pa., Southern N.Y.] .

J. L. CRAFT, Pa. Geol. Survey. Evaluation of Gravel Quality Problems, Upper Allegheny River, Northwest Pa. A field and laboratory study of the gravel quality conditions related to gravel terrace operation in the Upper Allegheny River. ACD: Summer 1978.

G. W. LENEY, U.S. Dept. of Energy, and BENDIX FIELD ENGINEERING CORPORATION. National Uranium Evaluation Program (NURE). Programs in progress in Pennsylvania include airborne radiometric surveys in Scranton, Newark, Williamsport, Harrisburg quadrangles, hydrogeochemical sampling in Scranton, Newark, geologic evaluation in Scranton, Newark, Williamsport, Harrisburg. (All 1° x 2° map series, scale 1:250,000.) Also miscellaneous research under NURE includes some work in Pennsylvania. ACD: 1979-83.

B. J. O'NEILL, JR., and J. H. BARNES, Pa. Geol. Survey, and K. J. LILES, U.S. Bur. of Mines. Properties and Uses of Clays and Shales in South-Central Pa. A continuation of the series of programmed studies to evaluate the economic potential of clay-shale raw materials for ceramic and nonceramic uses. ACD: 1979.

B. J. O'NEILL, JR., Pa. Geol. Survey, K. J. LILES, U.S. Bur. of Mines, and J. H. BARNES, Pa. Geol. Survey. Properties and Uses of Pennsylvania Shales and Clays, Southwestern Pa. A continuation of the series of programmed studies to evaluate the economic potential of clay-shale raw materials for ceramic and nonceramic uses. ACD: 1978.

B. J. O'NEILL, JR., and FIELD MAPPING DIVISION, Pa. Geol. Survey, and U.S. BUR. OF MINES. Investigations for High-Calcium Limestones in Pa. Objectives are threefold: (1) to sample and analyze limestone units where information is lacking, incomplete, or widely scattered; (2) to map any newly discovered, high-calcium limestone unit that has a potential for commercial extraction; and (3) to synthesize the data into publications which will be useful guides to exploration targets. ACD: Continuous.

H. M. PENLEY and T. A. BAILLIEUL, Bendix Field Engineering Corp. Scranton Quad. Evaluation [Scranton NTMS 2° quad., Pa.]. Uranium evaluation of the Scranton quadrangle for the NURE project (National Uranium Resource Evaluation). ACD: Mar. 1979.

R. G. PIOTROWSKI and J. A. HARPER, Pa. Geol. Survey. Stratigraphic Relations of the Devonian Organic-Rich Shales in the Subsurface of Western Pa. This project is a portion of the resource evaluation phase of the Dept. of Energy's Eastern Gas Shale Project. The study will include stratigraphic cross sections, isopach maps, facies distribution maps, and regional structure maps for the Upper and Middle Devonian clastics with special emphasis on the potential gas-producing Devonian organic-rich shales. ACD: Oct. 1978.

G. H. P. POPPER, Bendix Field Engineering Corp. Harrisburg Quad. Evaluation [Harrisburg NTMS 2° quad, Pa.]. Uranium evaluation of the Harrisburg quadrangle for the NURE project.

A. W. ROSE, SCOTT TREGASKIS, STEPHEN HOWE, The Pa. State Univ., and H. W. SCHASSE, The Pa. State Univ./Pa. Geol. Survey. Geology and Geochemistry of Pb-Zn Occurrences in Central Pennsylvania [mainly Centre, Huntingdon, Blair, and Bedford Cos.]. Pb-Zn near Woodbury and Mapleton is localized by late Paleozoic thrust faults or shears in areas of tight and complex folding. Includes studies of fluid inclusions and sulfur isotopes. ACD: 1978.

W. O. SHORT, Bendix Field Engineering Corp., and G. W. LENEY, U.S. Dept. of Energy. Catskill Delta [Carbon Co. near Jim Thorpe]. ACD: Late 1979.

R. C. SMITH, II, Pa. Geol. Survey. Trace Element Content of Sphalerite and Galena from Pa. Pure mineral concentrates of sphalerite and galena will be analyzed by atomic absorption, emission spectroscopy, x-ray fluorescence, and fire assay for such elements as Mn, Fe, Co, Ni, Ga, Ge, Ag, Cd, In, Sn, and Bi. The analyses will be evaluated for by-product, exploration, and environmental significance. ACD: July 1980.

ENGINEERING GEOLOGY

J. P. WILSHUSEN, Pa. Geol. Survey. Geologic Hazards in Pa. A descriptive report illustrated with maps, photographs, and sketches outlining the occurrence of geologic hazards in Pa. Natural geologic hazards in this state are (1) landslides and related phenomena, 2) sinkholes and solution phenomena, and 3) earthquakes. Each is discussed as a naturally occurring hazard and then in relation to the activities of man. ACD: July 1978.

ENVIRONMENTAL GEOLOGY

L. J. BACHMAN and R. R. PARIZEK, The Pa. State Univ. Environmental Geology of Moshannon Valley Area [Philipsburg, Osceola Mills and vicinity, Centre and Clearfield Cos., Pa.]. In this study, the ground water flow system in the Moshannon Valley area will be described, geologic factors affecting development in the area will be discussed, and the geology of a portion of the Sandy Ridge 7½′ quadrangle will be mapped. ACD: Mar. 1979.

R. B. FINKELMAN, U.S. Geol. Survey. Release of Toxic Trace Elements from a Burning Bituminous Culm Bank [Mather, Pa.]. ACD: Aug. 1978.

N. K. FLINT, Univ. of Pitt., and members of a Univ. of Pitt. team headed by Dr. M. A. Shapiro, School of Public Health. Ohio River Basin Energy Study (ORBES) [Pa.]. This is Phase II of a U.S. Environmental Protection Agency (EPA) project to assess the possible impacts from energy conversion in 6 states of the Ohio River basin through the year 2000. ACD: 1978.

N. K. FLINT and DARL ROSENQUEST, Univ. of Pitt. Landslide-Hazard Mapping in Squaw Run Area Watershed, Allegheny Co. This project involves field mapping at a scale of 1 inch to 200 feet of all landslides, both recent and ancient, using specially prepared topographic maps obtained through the recently organized Squaw Run Area Watershed Association. ACD: June 1978.

A. R. GEYER, Pa. Geol. Survey, and W. H. BOLLES, Pa. Dept. of Education. Outstanding Geologic/Scenic Features of Pa. Outstanding geologic/scenic features cataloged have values of such distinctive quality as to be of county, state, or national significance. More than 270 have been identified. About two-thirds of these have been investigated and photographed. ACD: Dec. 1978.

M. M. MARTIN and R. R. PARIZEK, The Pa. State Univ. Prediction of Acid-Mine Drainage Quality [Clarion Co.]. Overburden and water sampling is completed and chemical and statistical analysis is underway to relate acid-mine drainage quality to age and type of mine restoration and the chemical and petrographic characteristics of the coal overburden. ACD: Nov. 1978.

R. R. PARIZEK, E. G. WILLIAMS, The Pa. State Univ., and R. J. HORNBERGER, Univ. of Pa. Delineation of Acid Mine Drainage Potential of Coal-bearing Strata of the Pottsville and Allegheny Groups in Western Pa. A regional data base consisting of water quality parameters, coal-mining patterns, and geologic factors is being assembled. Computer mapping techniques are being employed in the analysis and graphic display of the data. ACD: July 1978.

J. P. WILSHUSEN, Pa. Geol. Survey, and M. E. HORNE, Consultant. Greater York Area Environmental Geology. A compilation of geologic information pertinent to the development and environmental protection of the greater York area, composed predominantly of maps with interpretive legends discussing geology, water resources, mineral resources, and engineering characteristics of bedrock and soils. ACD: Nov. 1978.

GENERAL GEOLOGY

D. M. HOSKINS, Pa. Geol. Survey. Highway Geology from Harrisburg to Philipsburg [U.S. 22-322] . This is a revision of General Geology Report 29. It will be an expanded guide to significant stratigraphic and structural geology stops along U.S. 22-322 from Blue Mountain to the Allegheny Front. ACD: Winter 1979.

W. R. SHIRK, Shippensburg St. Coll. The Geology of Southcentral Pa. Geology of the Great Valley, South Mountain, and Triassic Lowland with emphasis on environmental geology, applied geomorphology, and environmental land-use planning. Self-study field guide with road log and selected site analysis of 18 areas will be included. ACD: Early 1979.

J. P. WILSHUSEN, Pa. Geol. Survey. Geology of the Appalachian Trail in Pa. A description with map and figures discussing the geology along the approximately 215 miles of the Appalachian Trail in Pennsylvania with special attention to outstanding geologic features along the trail and visible from it. ACD: Jan. 1979.

GEOCHEMISTRY

MARY FEELEY and T. O. WRIGHT, Allegheny Coll. Geochemistry of the Jonestown Red Beds. ACD: 1978.

R. L. FOLGER, E. I. BAUCOM, R. B. FERGUSON, V. PRICE, J. D. HEFFNER, and P. L. JONES, E. I. duPont de Nemours and Company for Savannah River Laboratory. National Uranium Resource Evaluation/Hydrogeochemical and Stream Sediment Reconnaissance [eastern U.S.]. A total of approximately 12,800 stream water, stream sediment, and ground water samples were collected in the Williamsport, Harrisburg, Scranton, and Newark NTMS 1° x 2° quadrangles for uranium and associated multi-element analyses. ACD: Dec. 1978.

H. E. KOESTER, U.S. Geol. Survey. Ground-Water Quality in Pa. Data from the U.S.G.S. (WATSTORE) and B.W.Q.M. (STORET) systems are being assembled and computerized, located on stable base maps and interpreted by the use of select computer programs. A final report and atlas will show existing ground-water quality and will discuss problem areas. ACD: 1979-80.

A. W. ROSE, SIMON PIRC, P. M. TOLE, The Pa. State Univ. Uranium in Sandstones and Shales of the Catskill Formation [eastern and central Pa.]. The abundance of uranium in normal rocks and its stratigraphic and lateral variability are being investigated as a guide to uranium deposits. The uranium in zircons is being measured as a possible means of recognizing U-rich source areas. ACD: 1979.

GEOMORPHOLOGY

E. L. WHITE and W. B. WHITE, The Pa. State Univ. Geomorphology of the Appalachian Highlands. Principal karst landforms in the Appalachian Highlands were measured for 62 small watersheds between Pennsylvania and Alabama. These were related to both the fluviokarst character of the Appalachians and to the rock type and structural setting. ACD: Continuous.

W. B. WHITE, The Pa. State Univ. Caves of Pa. Compilation of descriptions of the caves of the Valley and Ridge Province is well underway with data on Blair, Centre, Huntingdon, and Snyder Counties largely complete. ACD: Summer 1978.

GEOPHYSICS

W. G. FARLEY, Bendix Field Engineering Corp., and LKB RESOURCES, INC. Thorpe Airborne Gamma Ray and Magnetic Survey [Newark, Scranton, Harrisburg, and Williamsport 1° x 2° quad.].

B. F. HOWELL, JR., The Pa. State Univ. Seismic Hazard Evaluations of the U.S. [conterminous 48 states]. Gumbel's statistical theory of extreme values is being tested to evaluate how well it can be used to predict the occurrence rates of large earthquakes from the occurrences of small earthquakes at any location. ACD: 1981.

P. M. LAVIN, The Pa. State Univ. Gravity Map of Pa. The gravity map (1:1,000,000) is being prepared using a contour interval of 2 milligals. ACD: Sept. 1978.

LISA LeCLAIR, JEFF TREMBLY, OTTO MULLER, and W. H. DIMENT, U.S. Geol. Survey. Gravity Survey of Western Pennsylvania. ACD: Sept. 1978.

ROB VAN DER VOO, A. N. FRENCH, and R. B. FRENCH, Univ. of Mich. Paleomagnetism of Appalachian Redbeds [Pa., Md., Va., and W. Va.]. Paleomagnetic studies are underway on Paleozoic redbeds in the Valley and Ridge Province of the central Appalachians. These redbeds include the Catskill, Rose Hill and Juniata Formations. ACD: 1979.

GLACIAL GEOLOGY

E. B. EVENSON, Lehigh Univ., L. A. SIRKIN, Adelphi Univ., and W. D. SEVON, Pa. Geol. Survey. Wisconsinan Deglaciation Chronology of Northeastern Pa. and Northwestern N. J.: A Mapping/Palynological/Radiometric Approach. Mapping of ice marginal deposits will provide the geometry of deglaciation. Provenance investigations will relate the moraines to the Laurentide ice lobe which deposited them. An absolute deglaciation chronology will be based on C^{14} dates from sediments identified, palynologically, as representing the Tundra (HERB) Pollen Zone. ACD: 1981.

D. E. MARCHAND, U.S. Geol. Survey. Map of Quaternary Deposits [central Susquehanna Valley, esp. Union and Snyder Counties]. ACD: Field work completed.

HYDROLOGY

E. S. BAIR and R. R. PARIZEK, The Pa. State Univ. Hydrogeologic Ramifications of Open-Pit Anthracite Mining [Tamaqua, Pa.; Southern Anthracite field]. The project entails a series of aquifer tests on various geologic materials under various geologic conditions likely to be encountered during the construction of a 2-3 square mile open-pit mine extending down to sea level. The purpose of the aquifer tests is to obtain valid field values of hydraulic conductivity, transmissivity, storativity, vertical leakage, and streambed infiltration rates which would be used in a finite-element digital model of the local ground-water flow system. The digital model would be used to predict ground-water flow rates and quantities into the mine for various configurations of the mine. ACD: Aug. 1980.

J. T. GALLAHER, U.S. Geol. Survey. Geology and Hydrology of Erie Co., Pa. The water resources of Erie County will be described. Special emphasis will be on glacial deposits. The occurrence and distribution of saline water will be described. ACD: 1980.

S. P. GARABEDIAN and R. R. PARIZEK, The Pa. State Univ. Streambed Infiltration in the Anthracite Coal Region. This project is still in the planning stages. ACD: Early 1979.

E. D. HESS, Pa. Geol. Survey. Water Well Inventory [Pa.]. Identifications of lithologic units, positioning of wells by coordinates, and analysis of rock units as potential aquifers. ACD: Ongoing.

G. R. SCHINER, T. F. BUCKWALTER, and C. H. DODGE, U.S. Geol. Survey. Water Resources of the Clarion River and Redbank Creek Basins in Western Pa. Provide basic ground- and surface-water information, oriented to the water and energy problems within the two basins, and to provide aid to the implementation of water-resources planning, management and development by water users. ACD: June 1978.

M. D. SINCAK, Cambrian-Somerset Council of Governments, and ULDIS KAKTINS and H. C. FRY, JR., Univ. of Pitt. Runoff and Flooding Characteristics of Solomon Run, Clayboard Run, Peggys Run and Sams Run located in Greater Johnstown, and related deficiencies in the design of numerous culverts and bridges along these waterways. ACD: Mar. 1978.

R. A. SLOTO and L. J. McGREEVY, U.S. Geol. Survey. Digital Model of Ground-Water Flow in Deeply Weathered Crystalline Rocks, Chester County. A digital model has been developed to simulate ground-water flow in the upper Pickering Creek basin in Chester County. The model simulates changes in the local hydrologic system which may be caused by potential development. ACD: June 1978.

R. W. SPILLER and R. R. PARIZEK, The Pa. State Univ. Statistical Approach to Ground Water Prospecting [eastern Pa.]. Water wells are being inventoried in eastern Pennsylvania and their positions classified as being located on or off photo linear features using aerial photos. Several statistical techniques are being used to determine if yields of wells located on such linear features differ significantly from wells located off such features. ACD: Sept. 1978.

J. B. URBAN, W. J. GBUREK, JAMES HOOVER, and WALTER HEALD, U.S. Dept. of Agriculture. Storm Water Detention and Ground-Water Recharge [Willow Grove, Pa.]. A porous asphalt parking lot has been designed and installed. The 25-year storm was used as the design criterion. ACD: 1982.

C. R. WOOD, U.S. Geol. Survey. Ground-Water Resources of the Gettysburg and Hammer Creek Formations, SE Pa. ACD: June 1978.

IGNEOUS AND METAMORPHIC PETROLOGY

M. L. CRAWFORD, Bryn Mawr Coll. Investigation of Metamorphic Rocks and Fluid Inclusions, SE Pa. Compositions and densities of fluid inclusions are being investigated to determine what correlation can be made between rock chemistry, metamorphic conditions, and fluid inclusion properties. ACD: 1980.

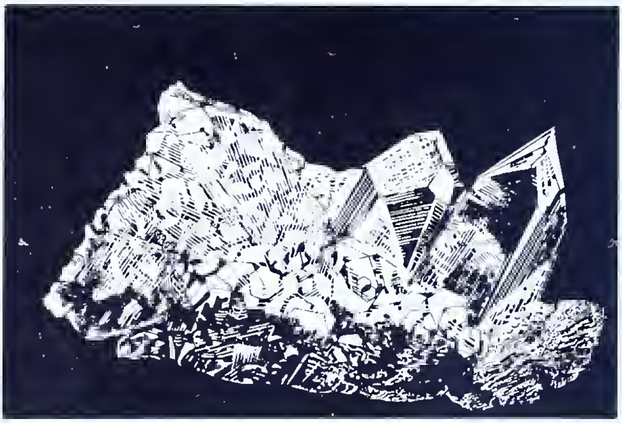
M. L. CRAWFORD and W. A. CRAWFORD, Bryn Mawr Coll. Metamorphic History and Development of the Pa. Piedmont [SE Pa.]. A comprehensive quadrangle by quadrangle remapping and restudy of the Pennsylvania Piedmont east of the Susquehanna River, to include the Honey Brook Upland.

M. L. CRAWFORD, Bryn Mawr Coll., M. E. WAGNER and JULIA HANDY, Univ. of Pa., and ROBERT COWARD, Bryn Mawr Coll. Chemical and Metamorphic Study of Mafic Rocks of the Piedmont [Piedmont south and west of a line between West Chester and Bryn Mawr]. Four groups of mafic rocks can be distinguished on the basis of their occurrence. The study attempts to determine whether or not these four groups are related to each other in age and/or tectonic setting and from this information to try to gain a greater understanding of the development of the central part of the U.S. Appalachian orogen. ACD: Mid 1979.

A. A. DRAKE, JR., R. I. TILLING, and P. T. LYTTLE, U.S. Geol. Survey. Petrochemistry and Radiogenic Heat Producing Minerals of Reading Prong Rocks [Pa., N.J., N.Y.]. Preliminary work suggests that hornblende-granite-alaskite suite has high heat productivity values and that sodic metasedimentary-metavolcanic rocks have unusual Th/U ratios. Work this year will be concentrated in eastern U.S. ACD: 1981.

A. M. THOMPSON, Univ. of Del., and DAVID GOLIKE. Petrogenesis and Structure of the Wilmington Complex, Chester Co. Field mapping and petrochemistry of granulitic metamorphic and igneous rocks in Chester County and adjacent Delaware. ACD: May 1979.

MINERALOGY



J. H. BARNES, Pa. Geol. Survey, and W. F. DOWNEY, JR., Juniata Coll. Mineralogy Associated with Burning Anthracite Deposits [Luzerne, Schuylkill, N. Dauphin Cos.]. Study of minerals forming from sublimation of gases produced by subsurface fires in anthracite mines and culm banks. ACD: 1978.

R. B. FINKELMAN and M. E. MROSE, U.S. Geol. Survey. Characterization of New Minerals from the Surfaces of Burning Culm Banks [anthracite and bituminous regions]. ACD: 1980.

D. T. HOFF, Pa. Historical and Museum Comm. Mineralogy of the Harry T. Campbell Sons' Quarry, Gettysburg, Pa. The geology, mineral associations, and paragenesis of more than thirty mineral species known to occur at the Campbell Quarry are described in detail. ACD: June 1978.

LORRAINE KREPS and T. O. WRIGHT, Allegheny Coll. Sedimentary Petrology of the Graywacke from Shochary Ridge and the Hamburg Klippe near Hamburg, Pa. ACD: 1978.

M. E. MROSE, U.S. Geol. Survey. Mineralogical Investigations. Continue mineralogical study of new minerals found associated with burning culm banks in Pennsylvania and finalize paper on Nd-rich carbonate hydrate from Saucon Valley, originally described as "lanthanite." ACD: Continuing.

R. C. SMITH, II, Pa. Geol. Survey. Mineralogy and Geology of Uranium Occurrences in Eastern Pa. The primary and secondary uranium minerals in sandstone host deposits will be briefly examined by x-ray diffraction and optical methods in an attempt to better understand the genesis of the deposits and the present-day leaching of uranium from the outcrop. ACD: Oct. 1978.

R. C. SMITH, II, M. L. ANNÉ and others, Friends of Mineralogy. The Mineralogy of Pennsylvania 1966-1975.

PALEONTOLOGY

T. M. BERG, Pa. Geol. Survey, and R. E. THOMS, Portland St. Univ. Comparison of Burrows of the Devonian Bivalve *Archanodon* with Those of the Holocene Bivalve *Margaritifera*. Burrow structures in the Middle Devonian Bellvale Sandstone of N.J. and N.Y. have been documented by Berg in the N.J. Acad. of Sci. as the work of *Archanodon*. A poster session covering progress of this research will be presented by the authors at the International Devonian Symposium to be held in Bristol, England, Sept., 1978.

J. A. HARPER, Pa. Geol. Survey. A New Eospondylid Ophiuroid from the Conemaugh Group (Pennsylvanian) of Western Pa. A small specimen identified as an eospondylid ophiuroid is described from the Brush Creek Shale of Punxsutawney. The family Eospondylidae is transferred to the order Oegophiurida based on ossicle morphology. ACD: 1978.

J. A. HARPER, Pa. Geol. Survey, and H. B. ROLLINS, Univ. of Pitt. Color-Banding in Pennsylvanian Gastropods of N.A. [including Pa.]. This will be a comprehensive study of color-banding preserved in gastropods from numerous horizons in the Pennsylvanian of North America. Emphasis will be placed on aspects of polymorphism and apparent mode of life. ACD: 1979.

D. M. HOSKINS, Pa. Geol. Survey. Fossil Collecting in Pa. (2nd ed.). General Geology Rept. All fossil localities will be reexamined to determine if still available and suitable for fossil collectors. New localities will be added where necessary. ACD: Winter 1978-79.

W. F. KLOSE II, Paleontological Research Inst.

1. Cones and Megaspores of *Lepidocarpon* from Pa. [NE Pa.]. Materials for the study collected and curated. Review of specimens (types) at the USNM completed. ACD: 1979.
2. Additions to the Coal Fauna (Allegheny) of Pennsylvania [NE Pa.]. Specimens of crustaceans, insects, and medusa found in the past few years will be treated. ACD: 1978.

3. The Flora of the Baltimore Coal (Allegheny) [Wilkes-Barre]. ACD: 1979.

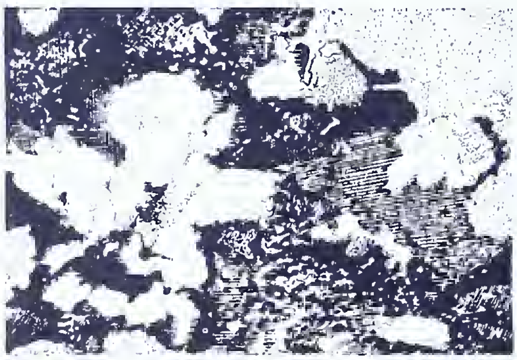
4. The Flora of the Sugarnotch 2 Vein. ACD: 1978.

5. The Flora and Fauna of the Buck Mountain 5 Coal [Southern Anthracite basin]. A study of fossil plants, insects, and crustacea from the Buck Mt. 5 coal (basal Allegheny Series) in the Southern Anthracite basin in the Klose, Badman, William Penn Memorial Museum, USNM, and Reading Public Museum (Unger Collection) collections. ACD: 1980.

MICHAEL McSTRAW and T. O. WRIGHT, Allegheny Coll. Lithologic and Faunal Similarities between the Graywacke at Shochary Ridge and the Ramseyburg Graywacke near the Lehigh River. ACD: 1978.

A. V. MORGAN, Univ. of Waterloo. A Beetle Fauna from Longswamp (Mertztown), Pa. A 4" diameter core has been recovered from Late Glacial and Holocene sediments at Mertztown, Pa. The core has produced a small but well preserved insect fauna (primarily Coleoptera) which is currently under investigation. ACD: 1979.

W. A. OLIVER, JR., U.S. Geol. Survey. Corals and Biostratigraphy of Keyser Limestone [Pa., Md., Va., W. Va.]. Systematic paleontology and distribution of rugose and tabulate corals are being studied. Field and lab work are 25% (est.) completed. ACD: 1982.



SEDIMENTOLOGY

EDWARD COTTER, Bucknell Univ. Silurian Shallow Shelf Sedimentation: Serenity and Storms [central Pa.]. ACD: Fall 1978.

J. C. FERM, Univ. of S. Car., W. A. BRAGONIER, R & P Coal Co., and GEORGE PEDLOW, Chevron Oil Co. Guide to Cored Rocks of the Pittsburgh Basin. Several thousand core samples from diamond drill holes were sampled and grouped into lithologically similar groups. Samples from each lithologic group were photographed and assigned a 3-digit lithologic code. A guidebook to the cored rocks will be assembled from the photographs. ACD: Apr. 1979.

J. D. GLAESER, Duke Univ., and J. D. GLAESER & ASSOCIATES. Devonian Slope Sedimentation in the Central Appalachian Basin:

Source and Reservoir Deposits. A detailed stratigraphic framework linking source and reservoir deposits has practical application to continent-margin slope deposits, probable stratigraphic pathways linking known organic-rich lower continental margin beds to potential reservoirs on the continental shelf of eastern N. A. ACD: Apr. 1978.

S. O. MOSHIER, SUNY at Binghamton. Depositional Regimes in the Upper Cambrian [Conococheague carbonates of SE Pa.]. Petrographic analysis, statistical evaluation of lithologic repetition or cyclicity and study of vertical changes and lateral correlation of sections as an aid in developing a depositional model for these rocks in their regional setting. ACD: May 1979.

D. E. ROUSE, Allegheny Coll., and C. H. DODGE, U.S. Geol. Survey. Petrology and Petrography of the Knapp Formation (Early Mississippian) of Northwestern Pa. Emphasis is on petrographic analysis of thin sections of Knapp Conglomerate Member. Samples were collected in Elk, eastern Forest, and McKean Counties. ACD: June 1978.

STRATIGRAPHY

T. M. BERG, Pa. Geol. Survey, and W. E. EDMUNDS, Consultant. The Huntley Mountain Formation of North-Central Pa. A new formation including the nonmarine transitional sequence between the Catskill Formation and the Burgoon Sandstone is being named. The formation has its type section at Huntley Mountain near Waterville, Pa. It has been mapped over about 4,000 square miles for the new state geologic map. ACD: Late 1978.

C. H. DODGE, U.S. Geol. Survey. Revised Stratigraphic Nomenclature of the Mississippian in Northwestern Pa. The stratigraphic nomenclature of the Mississippian of Clarion, Elk, Forest, Jefferson, and McKean Counties is being revised to conform with accepted usage, where appropriate, in Crawford, Venango, and Warren Counties. Work to date has concentrated on field investigations and subsurface data collection. Extensive use is being made of geophysical (primarily gamma-ray) logs for correlation purposes. ACD: 1980.

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V. A. SCHMIDT, J. D. DONAHUE, and H. B. ROLLINS, Univ. of Pitt. Paleomagnetism of Carboniferous Sediments in the Appalachian Basin [western Pa., eastern Ohio, northern W. Va.]. During the Carboniferous, the earth's magnetic field was predominantly in the reversed polarity configuration. Thus, any normal polarity events should serve as stratigraphic markers. The aim is to define a comprehensive magnetostratigraphy for the Appalachian Basin.

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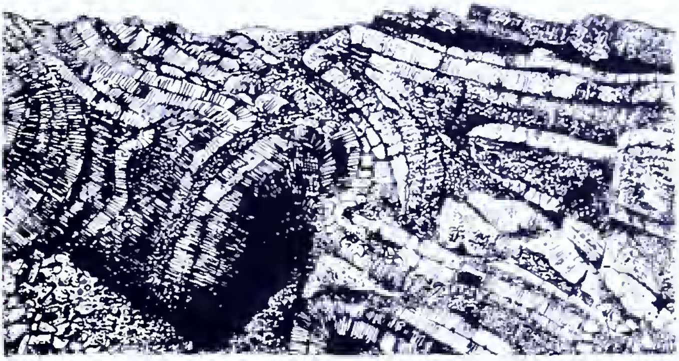
T. O. WRIGHT, Allegheny Coll., G. C. STEPHENS, Bryn Mawr Coll., and ELLEN WRIGHT, Allegheny Coll. Mid-Upper Ordovician Clastic Rocks of Eastern Pa. The stratigraphy of the Martinsburg and other rocks related to the Taconic Orogeny is being restudied to resolve existing ambiguities and to provide detailed evidence for paleogeographic reconstructions based on modern tectonic models. ACD: 1980.

STRUCTURAL GEOLOGY



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SURVEY ANNOUNCEMENTS

NEW GEOLOGIC ATLASES ISSUED

Three new geologic atlases have been issued by The Pennsylvania Geologic Survey for portions of Clearfield, Centre, Cumberland, Monroe and Pike counties. Each of the atlases contains detailed, full-colored geologic maps of the bedrock as well as the unconsolidated surficial deposits. The detailed maps (scale 1:24,000) and accompanying reports pay particular attention to the economic importance of the various geologic formations, as well as the engineering and environmental characteristics which will affect development and land-use planning. These atlases will be of importance to residents of the areas, planners, local officials, industry, and conservationists.

Atlas 85cd, *Geology and Mineral Resources of the Ramey and Houtzdale Quadrangles, Clearfield and Centre Counties, Pennsylvania,* by G. B. Glass and others, is available for $18.50 (plus tax for Pa. residents).

Atlas 138ab, *Geology and Mineral Resources of the Carlisle and Mechanicsburg Quadrangles, Cumberland County, Pennsylvania,* by S. I. Root, is available for $6.75 (plus tax for Pa. residents).

Atlas 214a, *Geology and Mineral Resources of the Skytop Quadrangle, Monroe and Pike Counties, Pennsylvania,* by T. M. Berg and W. D. Sevon, is available for $6.50 (plus tax for Pa. residents).

The above publications should be ordered from the State Book Store, P. O. Box 1365, Harrisburg, Pa. 17125.

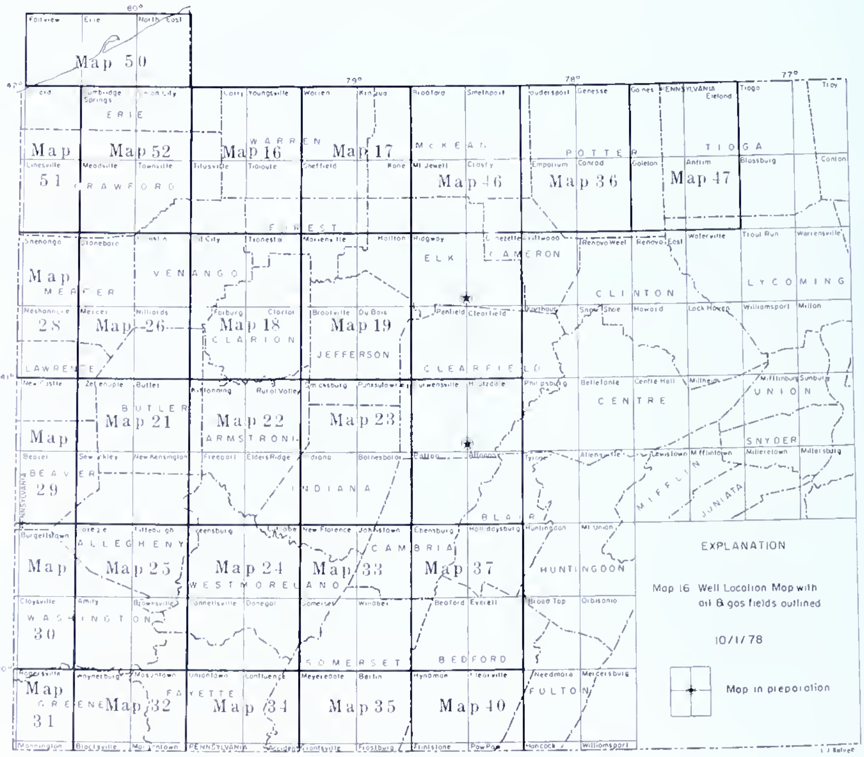
SURPLUS TOPOGRAPHIC MAPS

As a result of the ongoing program of revising and updating Pennsylvania's topographic maps, we now have a number of quadrangle maps which are out of date and are, therefore, surplus. These are still excellent for group or classroom instruction in map reading and profile exercises. These surplus maps will be provided at no charge as long as they last. Please advise how many different quadrangles are desired and how many copies of each quadrangle. Address requests to: Pennsylvania Geological Survey, 914 Executive House, Harrisburg, PA 17120.

NEW OIL AND GAS BASE MAP AVAILABLE

Three new oil and gas base maps, #50, 51, 52, are now available and twenty-two previously published base maps are also available. Each base map encompasses four 15-minute topographic quadrangles and is at the scale of 1 inch equaling a mile and shows locations of oil and gas wells and the outlines of the oil and gas fields. Refer to index map. A five-minute grid, quadrangle names, county boundaries, and major rivers and towns make up the background of the base map. All deep wells known and all shallow wells on record with the Pennsylvania Geological Survey are located, and the status (dry, oil producing, gas producing, etc.) is shown by symbol. Deep wells (Tully Formation or deeper) are differentiated and elevation and total depth are shown. Symbols indicate the availability of geophysical log and sample data on open file in the Survey's Oil and Gas Division office in Pittsburgh. An index map with the legend shows the outlines of oil and gas fields within the mapped area, thus indicating areas of extensive pre-1956 drilling. A listing of the field names is also included.

Paper prints of the base maps can be obtained by writing to the State Book Store, P. O. Box 1365, Harrisburg, Pennsylvania 17125. The cost of each base map is $0.50, plus a 6 percent sales tax to Pennsylvania residents. A check for the appropriate total amount made out to the Commonwealth of Pennsylvania must accompany the order. When ordering, please specify the map number.



URANIUM NEAR OLEY, BERKS COUNTY

Uranium has been discovered by the Pennsylvania Geologic Survey in pegmatitic gneiss near the headwaters of Monocacy Creek, 1 km (.6 mile) west of Oley, Berks County. Examination of outcrops of Precambrian gneiss along Pa. Route 73 with a Geiger counter on April 5, 1978, ultimately resulted in finding an area of approximately ½ x 1 kilometer (.3 x .6 mile) where the salmon-pink albite gneiss is enriched in uranium and, possibly, thorium.

Rock exposures in the area are few, but a 100 foot horizontal channel sample (excluding a 5 ft. covered interval and a 9 ft. barren, hornblende biotite gneiss zone) was collected by V. Skema and the author across the face of the inactive Moxon borrow pit (Figure 1). Radioactivity along the channel varied from 0.1 to 0.3 mR/hr, with the highest activity being associated with the more closely spaced N50±10 E-trending shear zones. Analysis of this sheared and somewhat weathered sample yielded 67 ppm U_3O_8. Reconnaissance with a gamma-ray spectrometer in the woods immediately above the channeled-sample section suggests that this exposure is typical of the overall pegmatitic albite gneiss in this area.

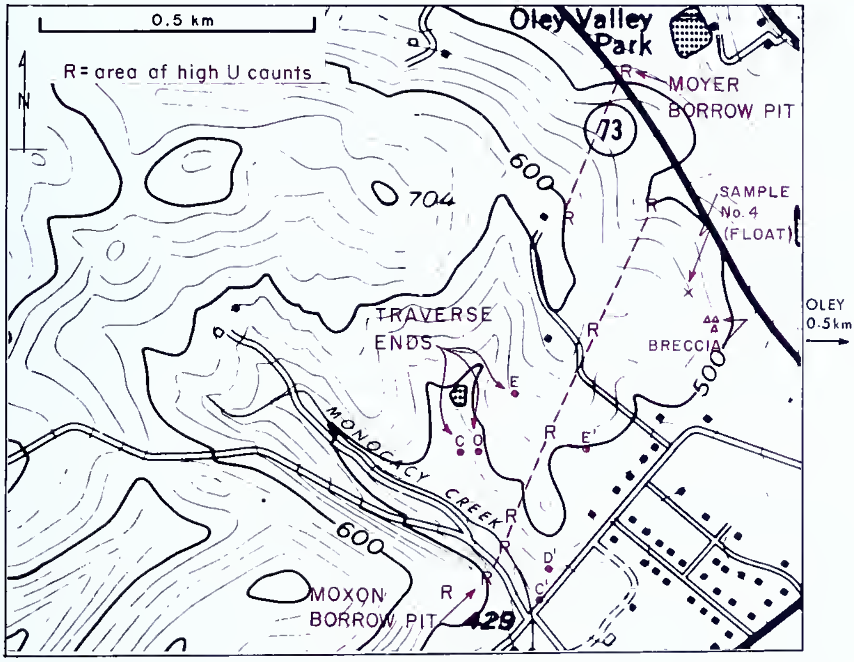


Figure 1. Location map of uranium mineralization in albite gneiss, Oley area, Berks County.

Five additional gamma-ray traverses (NW-SE) were conducted to determine the extent, variability, and orientation of mineralization. Figure 1 shows the areas where high uranium counts were found. The thorium counts were less variable and suggest smaller amounts of thorium. Figure 2 shows the variation in uranium counts along traverse E. Each traverse yielded a distinct 75 to 150 ft. wide uranium count anomaly above the already high background for this area. Continuity of anomalies between traverses has not been proven, but they may define three or more N20-25 E-trending zones enriched in uranium relative to the "normal" albite gneiss exposed in the Moxon borrow pit. The linearity of the hypothesized NE-trending zones suggests that the locus of more intense mineralization would be subvertical faults and/or shear zones. The presence of previously unmapped Hardyston Formation tectonic breccia in the area (Figure 1) suggests that additional structures are present.

Selected analyses of samples of albite gneiss collected from some of the uranium count anomalies are listed below:

Element or Oxide	Sample			
	1	2	3	4
Fe %	1.5	2	1	10
La ppm	70	70	50	500
Nb	20	300	200	500
Ti	200	700	500	2000
Y	20	70	50	1000
Zr	20	300	<20	200
U_3O_8	67	520	230	1100

Sample

1, 100 ft. channel sample from Moxon borrow pit.
2, float from area of highest counts on traverse D.
3, grab sample from 3-6 ft. wide zone in Moyer borrow pit.
4, float from stone pile in Moyer field.

Except for the fluorimetric uranium assays, the analyses are semi-quantitative via emission spectroscopy.

Thin films of fluorescent-green (under ultraviolet light) hyalite opal were found in both samples 2 and 4. Sample 4 was richest in uranium near magnetite, indicating that a magnetometer might aid prospecting. Also observed in sample 4 were golden-brown radioactive grains with a resinous luster and zircon-like structure and thin yellow films of an unidentified yellow secondary mineral along fractures.

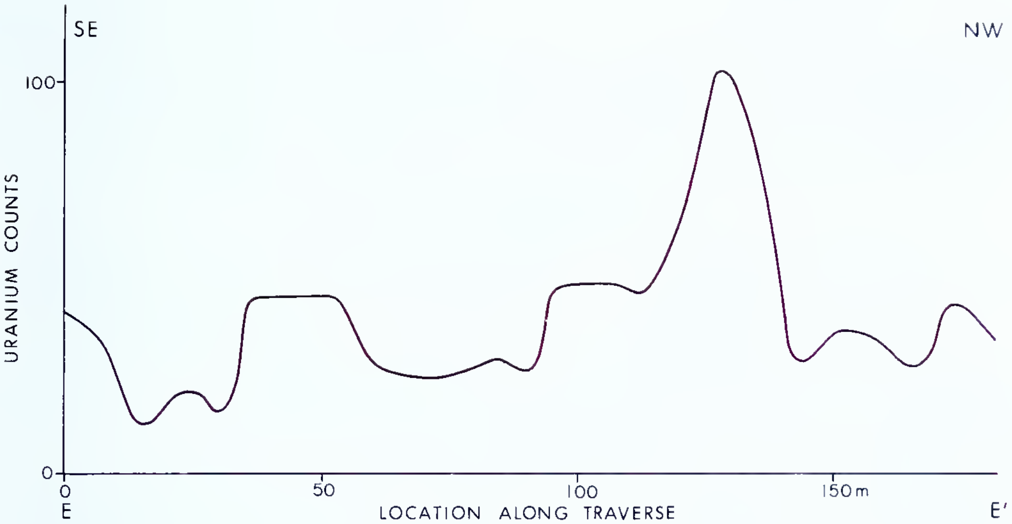


Figure 2. Variation in uranium counts along traverse E-E′, which trends S48E. The data were collected at 8 meter intervals along the traverse. Based on float sampling and trace element analyses, in this area, the 100 uranium counts from the instrument used probably corresponds to on the order of 200 ppm U_3O_8 in the surface float.

Neither of the two property owners, Jacob Moyer and John S. Moxon, desire to have anyone examine the properties without their advance permission. No collectable mineral specimens were observed.

From the data reported above it is not possible to evaluate the economic potential of this occurrence. Because of probable leaching of uranium from accessible samples, subsurface data is needed to properly evaluate the significance of this uranium mineral occurrence.

MINERALOGICAL SOCIETY OF PENNSYLVANIA ISSUES NEW BOOK

The Mineralogical Society of Pennsylvania has announced that "Annotated Bibliography of Minerals New to the Pennsylvania List, 1965-1974" written by Juliet C. Reed, has been published. The printing of this booklet was subsidized by the society and is offered for sale at the cost price, $2.75, plus $.50 postage and handling. To request, address Mrs. Reed at 336 Rockland Road, Wayne, PA 19087. Members of the society can obtain this book at no cost, and this book, plus the book "Mineralogy of Pennsylvania, 1922-1965," written by Arthur Montgomery and published in 1969, are available free to any library on request to the society. The book combines features of special interest to collectors and to mineralogical researchers.

Meet The Staff . . .

Robert Piotrowski, Chief
Oil and Gas Geology Division

On May 25, Robert G. Piotrowski was appointed Chief of the Oil and Gas Geology Division in Pittsburgh. Bob joined the staff of the Pennsylvania Geological Survey in May 1975 as a petroleum geologist in the Oil and Gas Geology Division. His first assignment was the Upper Devonian Stratigraphic Framework project, which consisted of preparing cross sections from well control points to calculate net sand and thickness of defined zones and units. This project was incorporated with the U.S. Department of Energy's Eastern Gas Shale project, of which Bob is the principal investigator for Pennsylvania. The two projects will be published by the U.S. Department of Energy. Since joining the Survey, Bob has had several of his reports published. He has authored papers on Onondaga reefs and Devonian shale gas for *Pennsylvania Geology*, co-authored several Survey annual development reports and map of the overburden on the Upper Freeport Coal, and authored a paper on oil and gas developments in Pennsylvania in 1977 for the International Oil Scouts of America.

Bob was born in Homestead, Pa. in 1948 but spent most of his childhood in Falls Church, Virginia. He graduated from the University of Dayton cum laude in 1970 with a B.S. in geology. After graduation from college he was drafted into the Service, where he spent most of his time in Korea working as a personnel specialist. Bob continued his education at Duke University, and he was awarded a two year teaching assistantship while working on his thesis on "Carbonate Sedimentation on U.S. Atlantic and Eastern Gulf of Mexico Beaches." He received his M.S. in geology in 1974.

Upon completion of school, Bob worked for the Amoco Production Company in New Orleans where he had previously worked one summer. As chief exploration geologist in the Hosston-Cotton Valley play in Mississippi, he interpreted logs, samples, and drilling data in order to recommend purchase of acreage.

Bob readily accepted the position with the Survey for the opportunity to live and work in Western Pennsylvania. He now lives in Bridgeville, a Pittsburgh suburb, with his wife Judy and daughter Jill.

Bob is a member of the American Association of Petroleum Geologists and a Member of the Board of Directors of the Pittsburgh Geological Society.

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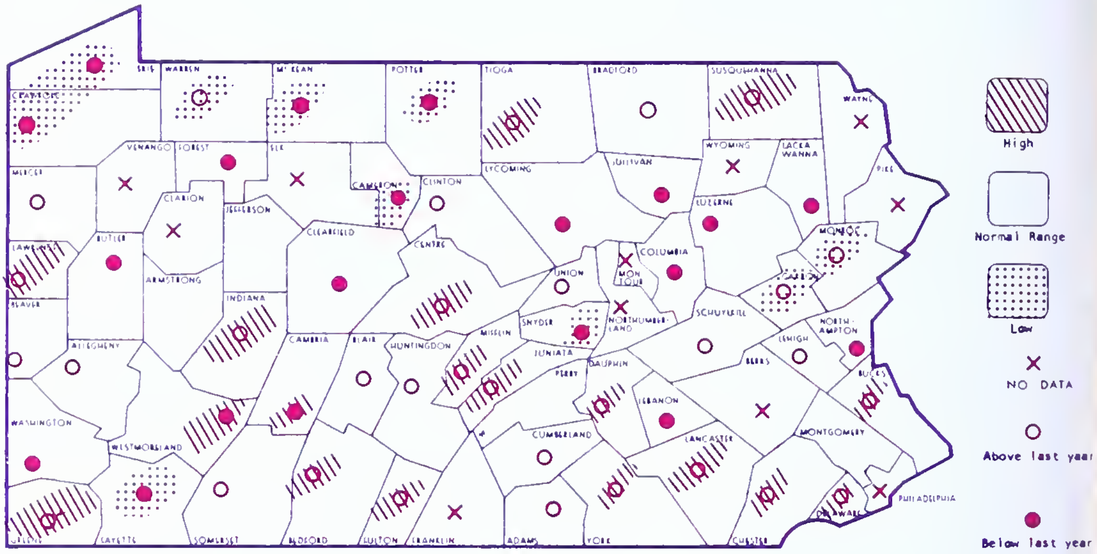

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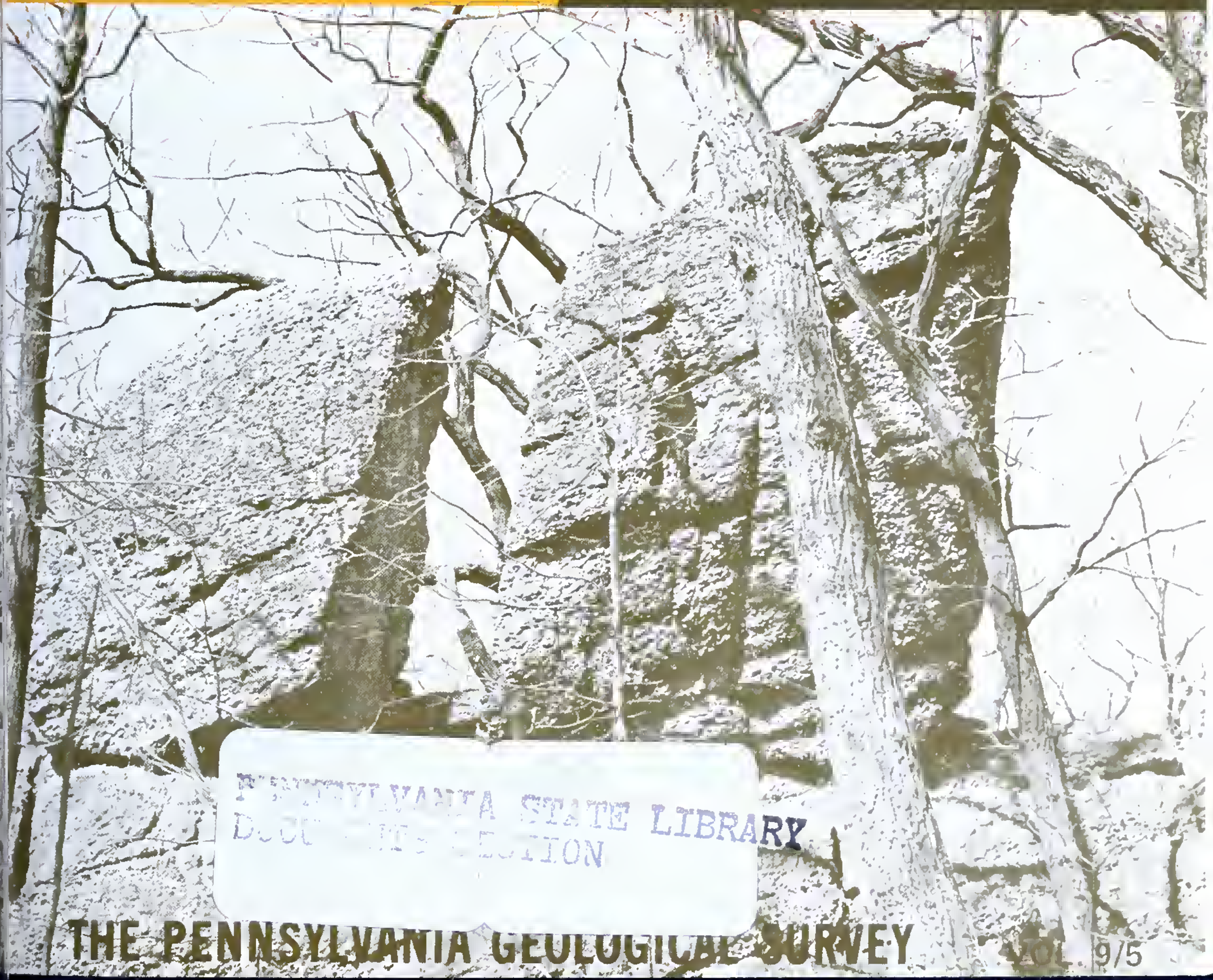

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TOPOGRAPHIC AND GEOLOGICAL SURVEY
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ON THE COVER: Chimney Rock, part of a ridge of Hellam conglomerate, one mile north of Hellam Borough, York County, Pennsylvania. Photo courtesy of William H. Bolles.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

Articles may be reprinted from this magazine if credit is given to the Topographic and Geologic Survey.

OCTOBER 1978

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

WHY NOT SUPPORT THE BASICS?

A few weeks ago a staff member of one of the federal agencies came up from Washington. He had called previously to invite our Survey to apply for federal money which was available for a specified type of research. My phone reply was apparently so incredulous to him that he asked to come and explain in person the available monies. After hearing him (and his two colleagues) out, I again replied that the type of exotic research he was urging us to undertake was extremely unlikely to be fruitful within the geological framework of Pennsylvania and, therefore, my responsibility as State Geologist and my conscience as a taxpayer would not permit me to go after this earmarked federal money. The expression on their faces was worth the time I lost.

This is not to say that the Pennsylvania Survey is not in need of additional funding, or that we are averse to accepting federal money. There is so much that remains yet to be done in our programs of geological mapping, coal and oil investigations, ground-water inventories, and geologic hazard delineation. But there's the "rub"! While there seems to be federal money available for exotic research projects, there is little or none available for basic resource mapping and data collection. Yet in geology, as in other sciences, the fact is that major advances and breakthroughs have to be built on a base of hard data, accumulated through years of tedious, non-glamourous field and laboratory work. The history of science is replete with examples of unfortunate ventures and conclusions for lack of proper data bases.

The wide use of our Survey reports and maps by research consultants to industry and government agencies, by college researchers, by fellow state agencies, and by industry and the public, all serves to indicate that we are producing needed and appropriate products.

I would hope that as they move to dispense their available monies, federal agencies as well as endowment funds recognize that we too serve as we systematically conduct geological surveys and develop the geologic data base of our region. These mundane efforts are important and are as worthy of financial support as the "exotics." And all who struggle with state budgets will readily attest to the critical need for outside financial support of these worthy programs.

Arthur A. Socolow

The Lancaster County Earthquake of July 16, 1978

Charles K. Scharnberger
Department of Earth Sciences
Millersville State College
Millersville, PA 17551

About 2:40 a.m. on Sunday, July 16 many residents of Lancaster County were awakened by what they thought was an explosion.

"I was awakened by what I thought must be a house exploding about five miles away. I lay there waiting for sirens to begin and I was amazed that [they] didn't."

"The earthquake felt like an extremely large amount of dynamite was being used at the nearby quarry . . . Our house vibrates slightly and the steel beams ring when the quarry is dynamiting. During the earthquake exactly the same things happened; however, it was much more intensified."

These were the responses of persons living in the Millersville area to a questionnaire which the Lancaster *New Era* carried four days after the earthquake. About 65 questionnaires were returned. These and an additional score of reports received by telephone and direct conversation were the basis for preparation of the earthquake intensity map shown in Figure 1. The questionnaire was designed to correlate the effects of the earthquake with the Modified Mercalli (or Wood-Neumann) scale of earthquake intensity.

The intensity map of Figure 1 is, of course, rather crude. Most information was received from the city of Lancaster and its suburbs. Here the isoseismal lines are well determined. Elsewhere, however, the lines are only approximate and dashed lines are used where no information was forthcoming, or where it proved impossible to separate areas of different intensity. It seemed clear, despite the uncertainties, that the maximum intensity was experienced around the small village of Smithville, south of Lancaster. Some of the effects in the area identified as Intensity V include: a cracked window, cracks in a basement wall, a night table overturned, objects rolled off tables, and a small slump along a creek bank.

In Conestoga, just beyond the intensity V area, very strong vibrations were felt and many people were frightened. Near the outside edge of the intensity IV area, curiosity rather than fear was the usual reaction. In the intensity III belt the noise was described as a low rumble, like distant thunder, and a mild vibration was felt. Two reports from the intensity III area described two rumbles a few seconds apart each accompanied by vibration. Both of these reports of a "double rumble" came from the same neighborhood north of Lancaster, located on a quartzite ridge.

A few other anomalous reports were received. A window was reported broken in the extreme southern part of the county, where the intensity should have been no greater than II or III. Respondants from the vicinity of Mount Joy and from northeastern York County reported vibrations stronger than those experienced by persons located closer to the intensity center. On the other hand, in Martic Forge, a village between Conestoga and Pequea, a weak vibration was felt and only a faint noise heard.

There may have been some precursive events to this quake. A resident of Pequea reported that his dog woke him up about 15 minutes before the earthquake, whining and evidently very disturbed. A woman living almost at the center of the area of inferred maximum intensity reported that in late May she and a neighbor had felt a vibration of the ground and heard a low gurgling sound coming from

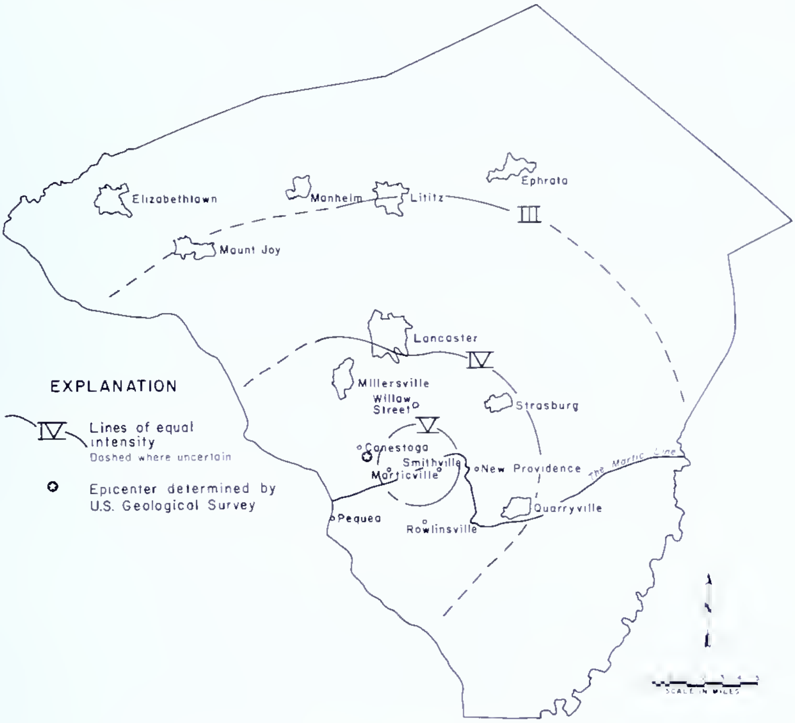

Figure 1.

underground. She could not be certain of the exact date and examination of seismograms recorded at Millersville during the second half of May disclosed nothing unusual. Whatever this phenomenon was, it was not a foreshock in the usual sense because it persisted for about an hour.

The United States Geological Survey's Earthquake Information Center reported the magnitude of the quake to be 2.9-3.0. The epicenter was placed at latitude 39.93° N., longitude 76.34° W., and the focal depth was estimated to be 5 km. This epicenter is shown in Figure 1. The intensity study suggests an epicenter slightly southeast of that of the U.S.G.S., but considering the uncertainties in both the intensity study and the instrumental epicenter location, there is no significant difference between the two.

The timing of this event was unfortunate, for none of the nearby stations of the developing Pennsylvania Seismic Network (including Millersville's) were operating at that early hour of Sunday. Once the network is fully operational (perhaps within a year) better epicenter locations and possibly fault-plane solutions will be available for earthquakes of this size.

This was not the first earthquake to have its epicenter in or near Lancaster County. On December 7, 1972 a tremor of maximum intensity V shook the area. The epicenter was apparently in the northeastern part of the county, probably in or near the Triassic outcrop belt of the Furnace Hills. A similar event occurred on March 8, 1889, with the strongest effects being felt in Berks County, east of Lancaster County. A somewhat stronger earthquake (magnitude 4.5) was centered near Cornwall, also in the Triassic belt, on May 12, 1964. (von Hake, 1977). The recent earthquake seems to be the first to have an epicenter not associated with the Triassic basins.

It is tempting to make certain correlations between the July 16 earthquake and geologic features of southern Lancaster County. These are tentative, but interesting nonetheless. The most obvious correlation is with the Martic Line, a prominent topographic feature separating the Martic Hills, underlain by late Precambrian or Cambrian Wissahicken Schist, from the Cambro-Ordovician phyllitic marble of the Conestoga Formation. The interpretation of this line has been the subject of controversy. Most recent work suggests that it is a folded thrust fault (Wise, 1970), although probably not with the large amount of displacement at one time thought. The July 16 earthquake seems to have been centered near a short north-trending segment of the line. This is significant in view of the fact that most earthquakes in the northeastern United States are associated with reverse faulting on north-trending faults. The regional stress field is one in which the axis of maximum compression is oriented east-west to northeast-southwest. (Sbar and Sykes, 1973).

Another possible correlation could be with the 40°N fault zone (or the Transylvania Fault) described by Root and Hoskins (1977). This fault zone is best exposed west of the Triassic basins, but if it is a major crustal fracture, perhaps related to the oceanic Kelvin fracture zone, then it could exist beneath southeastern Pennsylvania as well. However, there has been no historic seismicity on this fault zone.

Whatever the geologic origins of the earthquake, the people of Lancaster County do not appear to be excessively concerned about earthquake hazard. Surprise seems to be the most common response because "we don't have earthquakes here" (this despite the events of 1972 and 1964). There has been some apprehension about the danger to nuclear power plants along the Susquehanna River, but intensity V is not damaging to even moderately well-built structures. Yet the earthquake does show that the faults in the area are not completely dead, and no one could say with complete assurance that there will be no larger earthquake in the future.

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Wise, D. U. (1970), Multiple deformation, geosynclinal transitions, and the Martic problem in Pennsylvania, in *Studies in Appalachian Geology: Central and Southern,* Fisher et al. (eds.), New York: Wiley-Interscience, pp. 317-333.

Miles And Miles Of Pipelines

According to the Department of Energy, Pennsylvania has 8,097 miles of installed, underground petroleum pipelines. This ranks the Commonwealth seventh largest amongst all states. These serve variously to collect petroleum from the producing fields of western Pennsylvania and to carry petroleum and refined products across the state to distribution centers.

‘Nature To Be Commanded Must Be Obeyed’

A new book showing how earth-science maps are helping people make the best use of land and water resources in urban and suburban areas, even in the face of such geologic hazards as landslides and earthquakes, has been published by the U.S. Geological Survey.

"Nature To Be Commanded..." is the title of the illustrated 95-page, atlas-sized book. The title is taken from a translation of a 1620 quotation by Francis Bacon an English philosopher and essayist: "Nature to be commanded must be obeyed." "If we do not work with nature, but work against her, we may cause endless trouble for ourselves and sometimes invite disaster. To be obeyed, nature must be understood — which is where earth scientists come in."

The book says "Much can be done to stop or reduce losses from geologic hazards. Armed with information that indicates the kind, degree and location of potential hazards, planners and decision-makers can forestall or relocate new developments in areas where lives and property would be imperilled, they can propose appropriate design precautions in developments that cannot be placed elsewhere, and they can alert inhabitants of imperilled developments to seek protection through engineering or insurance."

Earthquakes, floods, landslides, coastal erosion and other geologic hazards cause an estimated $4.9 billion in damage in the United States each year, and take nearly 1,000 lives.

"Neglect of earth-science information is evident also in the mounting losses of mineral, water and agricultural resources due to inadequately controlled urbanization," it says. "When sand and gravel or coal deposits, groundwater recharge areas or prime agricultural lands are built over, the inevitable result is rising cost of basic construction materials, of fuels, of potable water, of food."

"Finally," the book adds, "failure to use earth-science information is apparent in the rapid growth of man-made and man-aided geological hazards; collapse of slopes due to excavation for structures or roads; subsidence of land due to mining or to the withdrawal of water or gas or oil; and contamination of ground water and surface water due to improper waste disposal."

Copies of the book, published as USGS Professional Paper 950 and titled "Nature To Be Commanded . . .," are available from the Branch of Distribution, U.S. Geological Survey, 1200 South Eads St., Arlington, VA 22202. The price is $6.25 per copy, and orders must be prepaid to the U.S. Geological Survey.

The Rogers Brothers And Lyell

by
Norman A. Pierce

A recent issue of *Pennsylvania Geology* (v. 9, no. 2, April 1978) contained an article entitled, "Charles Lyell and Pennsylvania," by Professor William R. Brice. The year of Lyell's arrival in the United States coincided with the last year of full, uninterrupted field work for the state surveys of Pennsylvania and New York, two of the best surveys financed by governments in ante-bellum America. The man directing the survey in Pennsylvania was Henry D. Rogers (1808-1866) who guided the Lyells along the hills and valleys in the eastern part of the state. This article will view Lyell's visit and related developments as recorded by Henry Rogers and his brother, William B. Rogers (1804-1882).

The Rogerses were two of a family of four brothers who were prominent members of the nation's scientific community in the Nineteenth Century.[1] At the time of Lyell's early visits William was Professor of Natural Philosophy at the University of Virginia and Director of the Virginia Geological Survey; Henry was teaching at the University of Pennsylvania, had made his final report as Director of the New Jersey Survey, and was engrossed in the Pennsylvania Geological Survey. These two men were as close in their thinking and harmony of spirit as two persons could be. Although their interests had been similar early in their careers, William's predominant attention stayed with chemistry while Henry moved into structural and dynamic geology. During the winter of 1832-1833, nine years prior to Lyell's first journey to this continent, Henry had spent several months in England during which time his interest shifted to geology. This was influenced by his participation in the meetings of the Geological Society of London. At that time Henry Rogers was introduced to Charles Lyell.[2]

The decade of the 1840's, when Lyell came to North America, were fruitful years for Henry and William Rogers: they travelled extensively on geological explorations outside as well as inside their states; they were among the founders and active participants in the Association of American Geologists and Naturalists. Before the decade ended, this Association, with continued strong support from these two men, was transformed into the American Association for the Advancement of Science.[3]

In the spring of 1841 Henry and William had been busy lobbying in the capital cities of their respective states for appropriations to continue the surveys in Pennsylvania and Virginia. After much effort each man was successful in gaining a year's extension. Henry at Harrisburg had to wait until the bitter end, at which time a general bill with a section to include the Survey was passed by the General Assembly over the veto of Governor David Potter.[4] In the spring, too, the second meeting of the Association of American Geologists and Naturalists was held in Philadelphia. Besides entering into the discussions, Henry served as an interim presiding officer. Because William was struggling with the Virginia legislature that week, he could not attend.

During the summer of 1841 the two men made a geological reconnaissance to Niagara, New York and the nearby territory in Canada and Ohio. They came eastward in time to meet Charles Lyell in Albany on August nineteenth. At this meeting, a projected trip into Pennsylvania was arranged. A month later Lyell wrote to Henry to make more definite the time he planned to spend in Pennsylvania. Lyell suggested that he wanted to study the higher elevations which later would be covered by snow. Also in that letter Lyell, after viewing some terrain along the border of New York and Pennsylvania, admitted that the formations below "the Coal and

Henry D. Rogers

William B. Rogers

Old Red" (Carboniferous and Devonian) were better developed in the United States than in Europe and "it will take years before justice can be done to it." This is along the same line of comment that Professor Brice quoted from Lyell's *Travels . . .* page 70. This statement only echoes an earlier one made by Henry in his *Second Annual Report . . .*dated January 27, 1838. In this report Henry had written:

> In the general review of the extensive series of our Appalachian formations now for the first time systematically classified and described, our attention is forcibly arrested by their vast thickness, the immensity of their range and the inexhaustible stores of mineral treasures which they contain . . . . Viewing the majestic scale of our formations, and the combined grandeur and simplicity of structure of the enormous Geological basin which they embrace, we turn with grateful satisfaction to the peculiar position which Pennsylvania occupies, in this vast area. Lying on the margin of the great secondary basin of the United States and traversed as it is, for nearly three hundred miles through its center, by the whole broad belt of the Appalachian or Allegheny chain, in which a system of gigantic anticlinal elevations, brings the entire series of formations, several times in succession to the surface, it holds in combination with . . . [other Appalachian states], the *key* to the Geology of many other states, where but a *part* of the same strata are spread out in a nearly horizontal attitude, and exhibited in but a single belt."[6]

It is unlikely that any man, not even brother William or those concurrently studying the terrain of New York, Tennessee, or other states, grasped so completely at this early date the big picture of the structure of eastern America. No one but Henry is likely to have considered it simple.

After Mr. and Mrs. Lyell had come to Philadelphia and completed their excursion into New Jersey under the guidance of Timothy A. Conrad (1803-1877), they were conducted into the anthracite coal area by Henry Rogers and William McIlvaine, who can be identified only as a friend of the Rogerses and who assisted them in coining names for geological periods.[7] Before this guided tour was undertaken Henry must have inquired from his brother as to how much Lyell should be taken into their confidence regarding their knowledge and theories. William, responding but not in time to reach Henry before he left up the Schuylkill Valley, wrote: ". . . I entirely concur with you in the plan of your proposed journey and your scientific intercourse with Mr. Lyell. My own reflections for a week past on this subject have impressed me with the importance of securing his good will, and if possible his friendship, by showing him the high philosophical import of our labours, and informing him frankly of our scientific plans. I feel as much or more than ever, the necessity of devoting some time this fall to the preparation of a memoir setting forth our leading views and discoveries, ..."[8] Lyell had the reputation of gleaning information from local sources with his "absorptive power and plastic mind" and subsequently presenting such gleaned data into his books and articles without always giving proper credit.[9]

A letter from Henry to William upon returning from his swing around eastern Pennsylvania with the Lyells related his general impressions of the Britishers. He stated, "If Lyell has been half as well pleased and satisfied with me as McIlvaine and I have been with him and his accomplished wife, I shall congratulate myself. I deem him a man quite too high-minded to encroach on the literary rights of others, and have many feelings towards him for the friendly interest he has shown in our future scientific progress."[10]

Henry then indicated that the Lyells planned to concentrate on the Tertiary deposits along the Atlantic coastal region as they journeyed south; and in this connection Lyell verified as Miocene a bed which Henry and his brother had earlier identified as such. As for the older strata, Henry wrote that Lyell indicated that fossils which he had collected in the Appalachians were similar to European Silurian specimens. Lyell was holding off a positive description of such specimens "which might be common to those in the New York rocks until Conrad's labours were published, unless, indeed, these were so delayed as to impede the progress unnecessarily" . . .[11] Lyell's reliance on Conrad's identification must have irked Henry who had referred to Conrad as a "closet" geologist in this letter. Conrad had brought Henry to task for confusing a gray sandstone with the Hudson River sandstone in his *Second Annual Report*. In an article in the *American Journal of Science and Arts* for 1839 Conrad admonished, "Not a single species of shells or plants is common to both . . . . This shows the great danger of error in endeavoring to identify strata over large areas, if we neglect to appeal to the evidence afforded by palaeontology, and rely too exclusively upon the ever varying mineral composition of rocks, which it is obvious may present similar features in groups of widely different age."[12] Although Lyell did not have to wait too long for Conrad's descriptions of Silurian fossils, the results were not in the form expected. Conrad, the palaeontologist of the New York Natural History Survey of 1836-1845, resigned in June 1842 without submitting a final report. He summarized his findings of the Silurian and Devonian systems in a paper to the Philadelphia Academy of Natural Sciences in January 1842.[13]

By the time of Lyell's visits Henry and William were planning a paper on the structural geology of the Appalachian region, an idea they had been mulling over since at least 1838. Three days after his description of travelling with Lyell, Henry wrote to William, "I did not state in my last [letter] how greatly I astonished Lyell at the breadth of some of our results and doctrines connected with *structure.* Though incredulous for the first day or two, even as to the thickness of our rock, I quite made a convert of him before we parted." He then suggested to William that he collect his ideas and notes on slaty cleavage, "for as a part of structure we ought to treat of it . . . ."[14] Later in October 1841 Henry commented that Lyell relied too much for identifying formations by their fossils and added, "But it is in the department of dynamic geology that, being foremost, we ought to be especially prompt in publishing. Reading Darwin on volcanic phenomena in the Andes . . . I have been particularly struck with conformitory evidence of the soundness of our idea of a pulsation having casued anticlinal axes. I am sure the doctrine will meet with acceptance."[15]

That winter the brothers discussed by letter the comparative relationship and nomenclature of formations in the Appalachians. At times Conrad's and Lyell's observations came in for comment and use. Fossil fish, which Benjamin Silliman (1779-1864) of Yale had uncovered in Connecticut and identified with Lyell's aid, appeared to Henry to verify his observation that "our red shale (Triassic) began directly after the upheaval of the coal."[16] So much for scoffing at the use of fossils in identifying formations!

Lyell wrote to William after Christmas, 1841 from Charleston, South Carolina to say that information supplied by William had assisted Lyell in collecting and identifying Tertiary beds. Lyell inquired whether William could return to Virginia with him after the Boston meeting of the Association of American Geologists and Naturalists and accompany him around the coal areas of Richmond and over the Allegheny Plateau to the Ohio River.[17] There is no record that William was able to oblige Lyell.

Henry in February 1842 showed some uneasiness about Lyell's use of information discussed between themselves as they examined the deposits in the anthracite region. In a letter to William he wrote that an abstract of a letter on the anthracite coal area from Lyell had been published by the Geological Society of London in such a way as to make Lyell the originator of its facts and ideas. Henry had thought that he had assurances from Lyell that any letter would be submitted as reflecting assistance and ideas from Henry.[18] But neither brother had time to fret over that matter because preparation for the Boston meeting of the Association of American Geologists and Naturalists took much of their attention. Both men participated actively in giving papers and in discussions of other topics. Their most important effort was their joint paper, "On the Physical Structure of the Appalachian Chain . . . ." After providing a detailed description of the Appalachians, the brothers argued that the chain was formed by the oscillation of a thin crust riding on pulsating, subterranean lava in combination with pressure from the northwest. They also tried to place the rise of this chain in geological time and compared it with mountains elsewhere.[19]

Lyell was the big drawing card at the Boston meeting. While the Rogerses had plenty of opportunity to converse with him, it remains unknown whether the subject of authorship of ideas expressed in his letter to London arose. Whether Henry refrained or not from raising the issue, a similar situation between Lyell and James Hall (1811-1898) of the New York Natural History Survey had been stirred up in public by a rumor that Lyell intended to incorporate information received from Hall and other geologists into a new edition of his *Elements of Geology*. Hall, who had contributed much time, knowledge, and the use of an unpublished map to Lyell, was aroused enough to write an anonymous letter, later acknowledged as his, to a Boston newspaper. This letter protested the Britisher's method of absorbing information from geologists of local regions for possible personal gain.[20] Lyell, therefore, was very aware of and alert to the general feeling about his use of information obtained from fellow scientists.

Less than a month after the Boston meeting Lyell wrote to Henry apprehensively from Marietta, Ohio about an article in *The Atheenaeum,* a British Publication, which attributed to a third person statements about Appalachian structure which Henry had expressed to Lyell in the previous October. To forego further chances for others to claim credit for the ideas presented by the Rogerses at Boston, Lyell urged Henry to submit an abstract of their paper on the Appalachian chain to the British Association for the Advancement of Science in time to be read at the 1842 summer meeting. Henry heeded this advice and submitted an abstract which generated a lively discussion at the Association's meeting in Manchester. Three leaders of British geology commented on the paper at this session. Roderick Murchison (1792-1871), while agreeing with the demarcation between the Palaeozoic series and later deposits, "was not prepared to give any opinion upon Prof. Rogers's undulatory theory." Sir Henry De la Beche (1796-1855) did not think that pulsation was necessary, only the lateral pressure. Adam Sedgwick (1793-1873), although not willing to accept the theory, complimented the United States "for the elaborate surveys they have published" and which will "serve along with similar phenomena to form the base of legitimate theory."[21] The theory based on pulsation was not as quickly accepted by notable geologists as Henry had predicted. Nor was it to be generally accepted later.

During the Lyells's second trip to this continent they do not appear to have made contact with the Rogers brothers. This seems a bit strange, especially in the case of Henry who had moved to Boston by 1846 and was seeking a professorship at Harvard College as well as lecturing in that area. It should be added, however, that at this time Henry was experiencing frustration in getting his final report for the Pennsylvania Survey published. William, in the meantime, was becoming discontented with the intellectual atmosphere of Charlottesville and his thoughts were turning to the means of producing a better environment for scientific and technical training than most colleges offered. In due course William would move to Boston and become the dominant person in the founding of the Massachusetts Institute of Technology. Both brothers were located in Boston for only a few years as Henry moved to Edinburgh, Scotland to supervise the printing of his final report of the Pennsylvania survey and in 1857 he received an appointment as Regius Professor of Natural History at the University of Glasgow.[22]

FOOTNOTES

[1] Emma S. Rogers, ed., *Life and Letters of William Barton Rogers* (Boston: Houghton, Mifflin & Co., 1896), 2 vols.

[2] *Ibid.*, 1: 98.

[3] Sally G. Kohlstedt, *The Formation of the American Scientific Community* . . . 1848-60 (Urbana, Ill., Univ. of Illinois Press, 1976), pp. 59-87.

[4] Rogers, *Life and Letters,* 1:180-90; *Pennsylvania Session Laws,* 1841, pp. 315 and 320.

[5] Rogers, *Op. cit.,* p. 193.

[6] Pennsylvania. State Geologist. *Second Annual Report on the Geological Explorations* . . . (Harrisburg: Packer, Barrett and Parke, 1838), pp. 82-3.

[7] Rogers, *Op. cit.,* pp. 194 and 199.

[8] *Ibid.,* pp. 193-4.

[9] John M. Clarke, *James Hall of Albany . . . 1811-1898* (Albany: privately printed, 1921), p. 107.

[10] Rogers, *Op. cit.,* p. 194.

[11] *Ibid.,* p. 195.

[12] T. A. Conrad, "Notes on American Geology," *American Journal of Science and Arts,* v. 35, Jan. 1839, pp. 243-3.

[13] T. A. Conrad, "Observations on the Silurian and Devonian Sys-

tems in the United States . . .,"*Journal of the Academy of Natural History,* v. 8, pt. 2, 1842, pp. 228-80.

[14] Rogers, *Op. cit.,* p. 197.

[15] *Ibid.,* p. 199.

[16] *Ibid.,* p. 202.

[17] *Ibid.,* p. 204.

[18] *Ibid.,* p. 207.

[19] William B. Rogers and Henry D. Rogers, "On the Physical Structure of the Appalachian Chain, as Exemplifying the Laws which have Regulated the Elevation of Great Mountain Chains, Generally," *Report . . . of the Association of American Geologists and Naturalists* (Boston: Gould, Kindall and Lincoln, 1843), pp. 474-531. See Kohlstedt, *Formation of American Scientific Community,* p. 69 for the comment that this paper was the most significant one ever given before a meeting of the A.A.G.N.

[20] Clarke, *Op. cit.,* pp. 118-127; Michele A. LaC. Aldrich, *New York Natural History Survey,* 1836-1845 (Ann Arbor, Mich., University Microfilms, 1974), 285-7.

[21] "Proceedings of the British Association, Sect. C: Geology and Physical Geography," *Journal of Science and Arts,* v. 44, Jan.-March 1843, pp. 359-61.

[22] Although the printing preparation for Henry's final report was done by the Edinburgh firm of W. Blackstone & Sons, the citation for the American edition is this: Henry D. Rogers, *The Geology of Pennsylvania: a Government Survey* (Philadelphia: J. P. Lippincott & Co., 1858), 2 vols.

New Pennsylvania Mineralogy Book

Friends of Mineralogy, Pennsylvania Chapter, announces the availability of *Mineralogy of Pennsylvania, 1966-1975* by R. C. Smith, II. This new book describes 62 previously unreported mineral species found in Pennsylvania during the ten-year period 1966-1975. Detailed descriptions and data are provided, plus precise directions to locate the locality of each of the new minerals.

The book contains many photographs and drawings, maps illustrating localities and a comprehensive glossary. A history of Pennsylvania mineralogy is included.

Mineralogy of Pennsylvania 1966-1975 can be obtained by writing to Bryon Brookmyer, Blue Ball, Pennsylvania, 17506. Make check or money order payable to Friends of Mineralogy, PA Chapter, in the amount of $14.95 plus 60¢ postage = ($15.55).

SURVEY ANNOUNCEMENTS

NEW GEOLOGIC ATLASES ISSUED

Two new geologic atlases have been issued by The Pennsylvania Geologic Survey for portions of Adams, Columbia, Franklin and Luzerne counties. Each of the atlases contains detailed, full-colored geologic maps of the bedrock as well as the unconsolidated surficial deposits. The detailed maps (scale 1:24,000) and accompanying reports pay particular attention to the economic importance of the various geologic formations, as well as the engineering and environmental characteristics which will affect development and land-use planning. These atlases will be of importance to residents of the areas, planners, local officials, industry, and conservationists.

Atlas 129c, Geology and Mineral Resources of the Iron Springs Quadrangle and Part of the Blue Ridge Summit Quadrangle, Adams and Franklin Counties, Pennsylvania, by J. L. Fauth, is available for $7.00 (plus tax for Pa. residents).

Atlas 174c, Geology and Mineral Resources of the Berwick Quadrangle, Luzerne and Columbia Counties, Pennsylvania, by J. D. Inners, is available for $12.00 (plus tax for Pa. residents).

The above publications should be ordered from the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125.

GROUNDWATER REPORT ISSUED

A new groundwater report has been published by the Pennsylvania Geologic Survey, dealing with Northern Berks County. This report provides basic data and descriptions and detailed hydrogeologic maps of the availability of subsurface water in the area investigated. With a growing population and an expanding consumption of water by industry, this report serves to focus attention on one of Pennsylvania's important, underdeveloped sources of quality water. This report will be of assistance to planners, developers, and all future water users.

This report is the product of an ongoing cooperative program with the Water Resources Division of the U.S. Geological Survey.

Water Resources Report 44, Ground-Water Resources of Northern Berks County, by Charles Wood and David MacLachlan, is available for $12.00 (plus 6% tax for Pa. residents) from the State Book Store, P. O. Box 1365, Harrisburg, Pa. 17125.

1977 OIL AND GAS DEVELOPMENTS

The record of oil and gas drilling, production, and reserves for Pennsylvania in 1977 is presented in a report newly released by the Pennsylvania Geologic Survey. The 39-page book, entitled "Oil and Gas Developments in Pennsylvania in 1977", is co-authored by Louis Heyman and Cheryl Cozart. This latest annual report on the subject provides data for the year as well as comparisons with activities in prior years. Particularly noteworthy was the drilling of 1372 new oil and gas wells, an increase of 167 over 1976, and the production of 2.7 million barrels of crude oil and 92.3 billion cubic feet of natural gas.

Progress Report 191, Oil and Gas Developments in Pennsylvania in 1977, is available for $1.40 (plus 6% tax for Pa. residents) from the State Book Store, P. O. Box 1365, Harrisburg, Pa. 17125.

BIBLIOGRAPHY OF GEOLOGIC FIELD TRIP GUIDEBOOKS RELEASED

This bibliography compiled by Sandra Blust strives to gather the published guidebooks for field trips to 1977 which took place within the geographic boundaries of Pennsylvania and to briefly annotate each.

The guidebooks are categorized into four groups: 1. Those published by the Pennsylvania Geological Survey, 2. Guidebooks from the Annual Meetings of the Field Conference of Pennsylvania Geologists, 3. Guidebooks prepared by the Geological Society of America, and 4. Guidebooks prepared by other geological societies. Following the written descriptions for each field trip category is an index map tracing the road log for each excursion.

Copies of the bibliography are available at no charge from Pennsylvania Geological Survey, Department of Environmental Resources, P.O. Box 2357, Harrisburg, Pennsylvania 17120.

NEW PARK GUIDE AVAILABLE FREE

The geology of Gifford Pinchot State Park, York County, is described in a fold-out pamphlet issued as Park Guide 10. The brochure illustrates the geology through map, sketch, and photographs with selected localities described where the predominant rock type, diabase, may be examined. Copies of Park Guide 10 may be obtained at Gifford Pinchot State Park or by writing to the Bureau of Topographic and Geologic Survey, P.O. Box 2357, Harrisburg, PA 17120.

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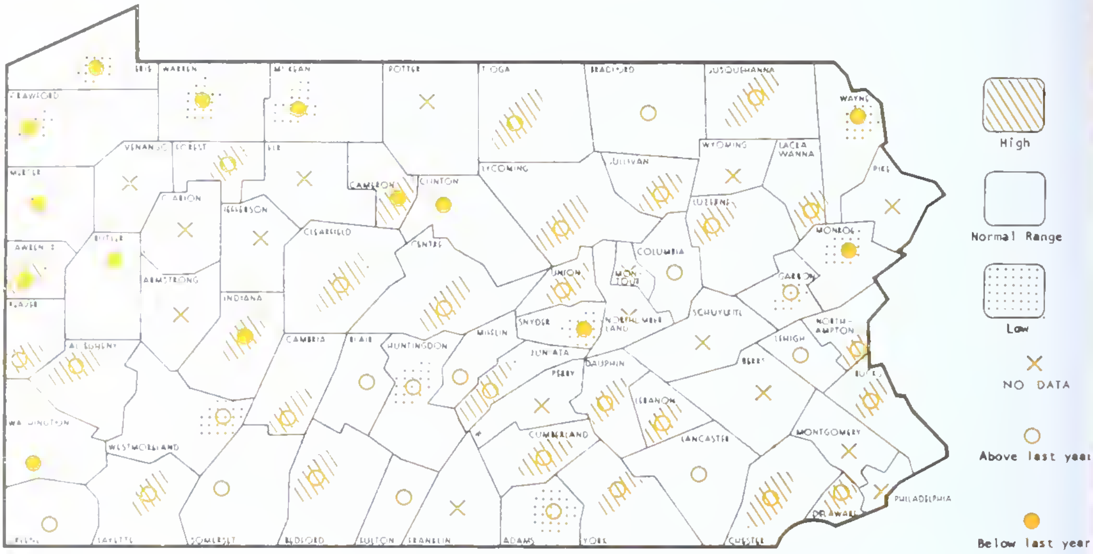

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THE PENNSYLVANIA GEOLOGICAL SURVEY

VOL. 9/6

COMMONWEALTH OF PENNSYLVANIA
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DEPARTMENT OF ENVIRONMENTAL RESOURCES
Maurice K. Goddard, Secretary

TOPOGRAPHIC AND GEOLOGICAL SURVEY
Arthur A. Socolow, State Geologist

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ON THE COVER: Peach Bottom Slate, of Lower Paleozoic age, exposed in quarry near Delta, Pennsylvania (York County). Photo shows crenulations on drag folds related to fracture cleavage. Slate contains well developed flow cleavage, fracture cleavage, joints, and lineations. Photo by J. P. Wilshusen.

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DECEMBER 1978

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

IS REACTION TO CRISIS THE ONLY WAY?

At a time when so many of the basic economic "laws" that I was once taught are being shown to be inoperative and essentially repealed by human greed, I still think back to the professor who stressed that a nation has only two fundamental sources of economic wealth: its natural resources and the labor it can muster to harvest and utilize those natural resources. Our nation blossomed and expanded in the 18th and 19th centuries by virtue of its abundant agricultural and mineral resources. And with a population expanding both in size and area of distribution, there was the need and motivation to develop and harvest the resources of our nation – and so it prospered and bountiful quantities of agricultural commodities and mineral resources were brought into production.

In the most recent couple of decades, as the nation found that it was able to supply its quantitative needs of agricultural and mineral resources, it began to pay attention to the quality of its production methods. And so there has come to pass great and proper emphasis on the environmental and conservational aspects of agricultural and mineral production.

But the indications are growing that there will have to be renewed attention and emphasis paid to again stimulate the quantitative aspects of our natural resources production. A growing world population is going to need increasing quantities of food, even from us. Our own economic machine is beginning to recognize that our once plentiful mineral resources are no longer so plentiful. At the same time, foreign sources of mineral products are becoming more and more difficult to reach; their own developing nations are beginning to utilize those resources at home, while various geo-political factors further reduce our access to those essential mineral resources.

The lesson we should learn from this sequence of events, past and present, is that we must exert renewed efforts to develop at home new sources of the wide array of minerals of which we are so rapidly running short.

Is our nation capable of learning the lessons of past experience and future needs in time to muster the efforts for timely and sound development of our mineral needs? Or will we wait until we react to a crisis?

Arthur A. Socolow

Another Lancaster County Earthquake

Charles K. Scharnberger[1]

Lancaster County is not what one usually considers "earthquake country," but residents were beginning to think of it that way after the second earthquake in three months struck about 3:25 p.m. on Friday, October 6. Because of the time of day, this tremor was felt by a far greater number of people than the July 16 quake which occurred at 2:40 a.m. The epicenter, as determined from intensity reports, was located only 5 km. from the center of the City of Lancaster. The July epicenter was about 15 km. from the city's center. In July, only about 65 newspaper questionnaires soliciting intensity information were returned, but this time the response was close to 400. The result of the intensity survey is shown in Figure 1.

Some of the most useful intensity data was supplied by students in earth science classes taught by Mr. Richard Brown at the Manheim Township Middle School, situated about 2.5 km. northeast of the inferred epicenter. Many students who live in two developments just south of a quartzite-schist ridge known as Blossom Hill reported effects that would fall in the intensity VI category of the Modified Mercalli scale. These effects included: fallen plaster, cracked foundations, pictures and mirrors knocked from walls, and bric-a-brac knocked from shelves.

There were many reports of pets behaving in an excited manner a few minutes before the first sound or vibrations were experienced by humans. Dogs generally whined and acted as though they wanted to be let out, yet would not venture off porches. Rodents scrambled frantically in their cages and even goldfish were reported to have raced and splashed in their bowl shortly before the quake. These reports of animal behavior all came from within or very near the maximum intensity zone.

The general experience was the same for this earthquake as in July: a loud explosive sound followed by vibrations that lasted a

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[1] Department of Earch Sciences
Millersville State College
Millersville, PA 17551

few seconds. As in July, a few persons reported feeling two distinct vibrations.

An interesting feature of the intensity map is that some areas farther away from the epicenter had greater intensities than areas closer in. Such areas of anomalous intensity were located in both the northern and southern parts of the county and correlate with highlands. In the north this is the area of the Furnace Hills, underlain by Triassic terrestrial sedimentary rocks and mafic igneous rocks. In the south the intensity was enhanced in the Martic Hills, underlain by quartzite and schist of the Glenarm Series.

Unlike the July earthquake, this event was recorded by the Millersville seismograph. A tracing of the seismogram is shown in Figure 2. The arrival of the S-wave may be indicated by the change of frequency which occurs 1.5 seconds into the record. The rock in the epicentral area is the Ledger Dolomite and the seismograph is located in the Conestoga Limestone. Reasonable average values for the velocity of P and S waves in dolomite or limestone are 5.5 km./sec. for P and 3.0 km./sec. for S. Assuming these values and an S - P time of 1.5 seconds gives 10 km. for the distance to the epicenter. This is almost exactly the distance from Millersville to the area of maximum intensity.

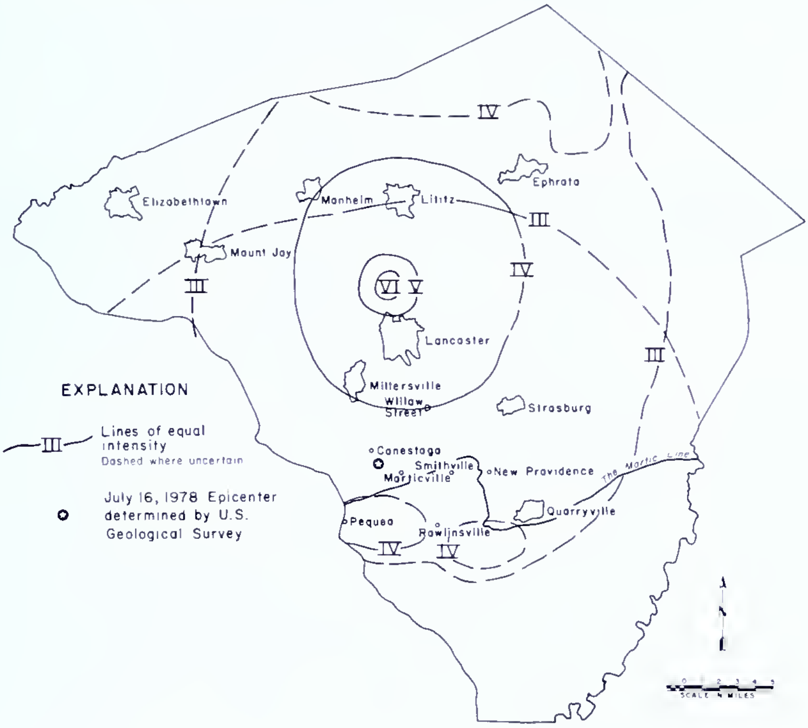

Figure 1.

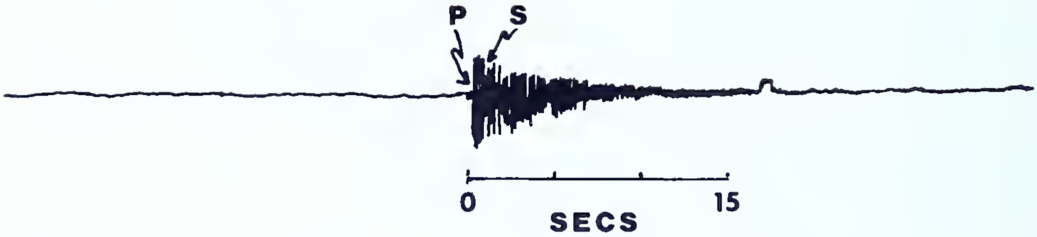

Figure 2

Seismologists in the Department of Geosciences at The Pennsylvania State University estimated the magnitude of the October earthquake to be 3.1 compared to 3.0 for the July event. Allowing ± 0.1 uncertainty in magnitude determinations, there was no significant difference between the two, yet the October event produced greater intensities than the quake in July. This could be because the October earthquake had a shallower focal depth than the one in July. A shallow focal depth would also be indicated by the fact that no allowance for depth had to be made to get agreement between the distance to the epicenter determined from the seismogram and the distance to the epicenter based on intensity reports.

Figure 3 shows the location of mapped faults in the maximum intensity area (Meisler and Becher, 1970). The Blossom Hill fault

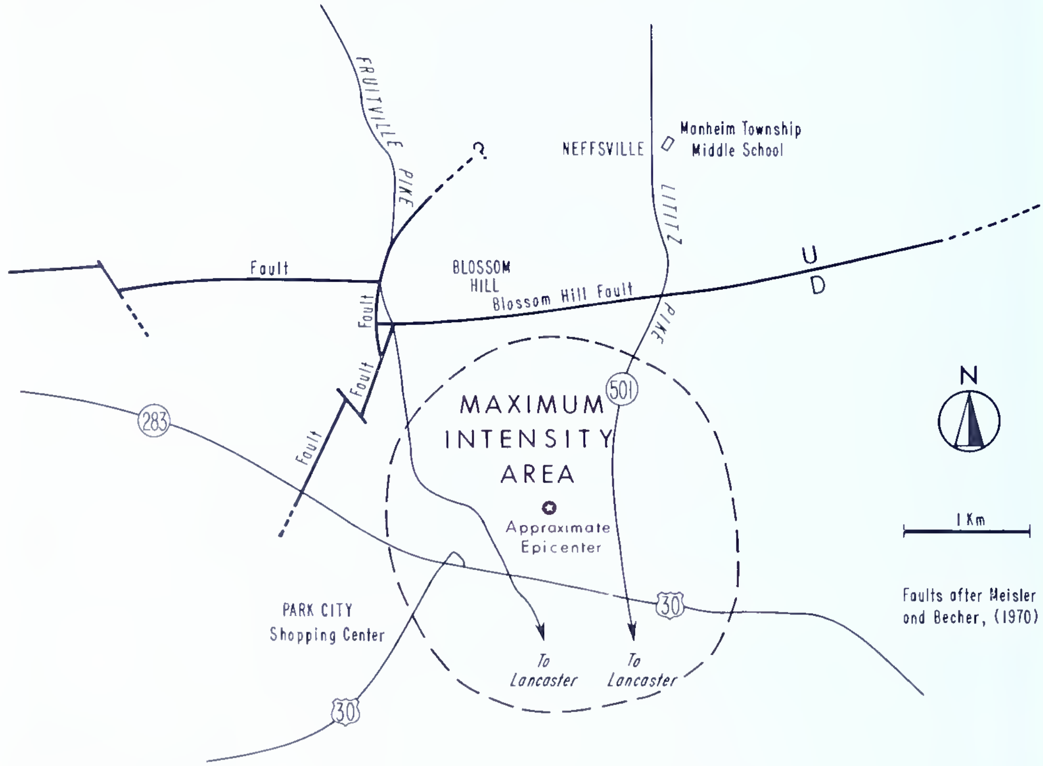

Figure 3

marks the southern margin of a horst of Antietam-Harpers Formation (quartzite and schist) surrounded by carbonate rocks. This fault probably dips south at a steep angle which would be consistent with the location of the epicenter on the south side of the fault trace. However, there is also a set of roughly north-striking faults in the area and there is an obvious dextral strike-separation of the Antietam-Harpers ridge along the northernmost of these faults. Because earthquakes in the northeastern United States are usually associated with north-striking faults (Sbar and Sykes, 1973), these faults to the west of the epicenter are more suspect than the Blossom Hill fault. Given the regional stress field of maximum compression horizontal and directed east-west (Sbar and Sykes, 1973), reverse faulting would be expected.

Are there more Lancaster County earthquakes to come in the near future? After the July earthquake I told a reporter that there was very little chance of another one for at least several years. I was proved wrong in 12 weeks. This time I am making no predictions.

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Engineering Geologists Meet in Hershey

Concerned with the need to cope with the relationship of geology to modern engineering practices, over 300 members and guests of the Association of Engineering Geologists met at the Annual Meeting of the Association in Hershey, Pennsylvania during the week of October 14-20. The sessions began with a weekend workshop on "Engineering Geology for Geologists" and continued with two days of field trips, two days of technical sessions and a one-day symposium dealing with "Geological Engineering in Karst Regions."

The workshop was jointly sponsored by the Association of Engineering Geologists and the Education Committee of the American Geological Institute. Approximately 30 noted speakers addressed a wide range of topics which were collectively designed to provide an insider's look at the specialized practice of geology as related to engineering. Copies of the lecture notes for the session are available from the American Geological Institute.

Three field trips were conducted to visit features of significance to engineering geology in central Pennsylvania. The first trip covered the Lower Susquehanna River Power Complex from Middletown to Conowingo Dam. The second trip included features in the Ridge and Valley physiographic province between Harrisburg and the vicinity of Penns Cave in Centre County. A third trip examined features of the Northeast Pennsylvania anthracite coal region; emphasis for this trip was on subsidence in mine areas and mine acid drainage.

During the two days of technical sessions, over 70 papers were presented. Separate half-day sessions covered the general topics: Mine Subsidence Control, Slope Stability, General Geology and Hydrogeology, Quarries and Waste Disposal, Planning and Land Use, Geophysics and Instrumentation, Dams and Dam Foundations, and Foundations and Power Plants.

The symposium on Geologic Engineering in Karst Regions was organized and moderated by Dr. Richard M. Foose, Professor of Geology at Amherst College. Topics discussed in the day-long session included: Geology and Hydrology of Karst, Catastrophic Surface Collapse Caused by Dewatering, Review of Geophysical Approaches to the Detection of Karst, Remote Sensing Techniques and the Detection of Karst, Foundations for Dams in Karst and Mining Problems in a Karst Valley. Dr. Foose discussed Engineering Geologic Approaches to Foundations in the Karst Terrain of the Hershey Valley, and conducted a short field trip to examine features of interest. Special problems affecting the Hershey Medical Center and other major structures were discussed.

It is interesting to note that the Association of Engineering Geologists, an international organization with about 2500 members, chose to have their annual meeting in central Pennsylvania this year because of the numerous practical examples of engineering geology available here. AEG's final announcement for the session called attention to many Pennsylvania places and projects which exemplify that engineering geology has played an important role in our State's development throughout history. State Geologist, Dr. Arthur Socolow also called attention to this fact in his remarks to the group at the opening session of the meetings.

The Bambford Zinc Mine: A Tribute

by Jeri L. Jones

Once where zinc was mined, cereal products are now being manufactured. Again industrialization has taken its toll among historical geological landmarks. The Bamford Zinc Mine is such an example.

The Bamford Mine was located in East Hempfield Township, Lancaster County, Pennsylvania, six miles northwest of Lancaster and one and one-half miles southeast of Landisville. Prior to the spring of 1974, the mine was located in a small wooded area on the north side of Yellow Goose Road, just south of Rt. 283, and was owned by J. I. Dellinger, who resides on the south side of Yellow Goose Road. Numerous dumps, building foundations, and several slag piles were the only evidence of previous mining activity there. In the spring of 1974, the Kellogg's Cereal Company of Battle Creek Michigan purchased the land for the construction of a new plant. It was during this construction that numerous dumps and one of the shafts were exposed. Some new and interesting mineral specimens were also uncovered.

The discovery of the ore at Bamford took place in 1845 when someone was digging holes for a fence and his shovel turned up some lead ore. This ore was taken to a Lancaster chemist for analysis, which showed zinc, lead, and traces of silver. Between 1847 and 1907, four different companies worked the veins (Landis, 1904).

The various Bamford Zinc Mine owners sank three shafts, which had an average width of twelve feet. The richest ore was found at the 75-foot level with the ore never exceeding 12% zinc. Work was apparently halted because the ore ran out below the 125-foot level on the two known veins (Frazer, 1880). Mosier (1948) estimated that about 25,000 tons of ore and waste rock have been removed from the mine since its discovery. Freedman (1972) estimated that approximately 3,000 tons of zinc was recovered. After the zinc was mined at Bamford, the ore was hauled to the railroad station at Landisville, but later a siding was laid from the Pennsylvania Railroad main line directly to the smelter. The cost of producing a pound of zinc in 1877 was $0.05; the sale price ranged from $0.07 to $0.11 (Frazer, 1880).

The rocks in the shafts and immediate vicinity of the mine are part of the Ledger dolomite. This formation has not only produced zinc, silver, and copper minerals in Lancaster County, but also in York County (Gordon, 1922). Several areas of shale belonging to the Kinzers Formation intertongue with the Ledge dolomite near the mine, particularly to the southeast and east.

Although Bamford was not one of the more famous Lancaster County collecting spots (compared to Cedar Hill quarry and Pequea mine, for example), Bamford has produced an interesting series of zinc and associated minerals. Primary minerals include galena, sphalerite, calcite, pyrite, saddle-shaped dolomite crystals, and chalcopyrite. One crystal belonging to the tetrahedrite-tennantite series (probably tennantite), was also collected. Secondary minerals include "dry-bone" smithsonite, hydrozincite, fine crystals of hemimorphite and cerussite, limonite, and malachite after the chalcopyrite. Two micro-crystals of azurite, not previously reported from this site, lying on the aurichalcite and the aurichalcite and chalcopyrite were also collected. Freedman (1972) reported finding both anglesite and argentite, a silver mineral, at the mine.

Presently very little of the Bamford Zinc Mine remains. Where once the small wood area stood hiding the mine ruins, there now stands a multi-million dollar structure. On the south side of Yellow Goose Road where once a large dump existed, there now are several small structures. The Bamford mine is now a part of Pennsylvania's rich mining history.

FAREWELL BAMFORD

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STATUS OF THE WATER WELL INVENTORY

by Eugene D. Hess[1]

In the past one and one-half years much of the effort to translate data on domestic water wells for computerized retrieval has been concentrated on wells from the central and south-central counties. Most of the new well records for these counties have been processed and will shortly be available on computer printed reports along with updated data of a few eastern and western counties. Many other counties processed in the past few years are now retrievable thanks to cooperation of the U.S.G.S.. Every county now has some available water well data retrievable via computer.

For the past two years the well data that is translated to the computer have been selectively chosen according to the accuracy of the well site description and the accompanying data. Since most of the well record cards that come into our office from well drillers cannot be field checked, we rely upon the sketch map and written description of the well location. Maps and explanatory notes have been sent to each driller with the result that many well site descriptions have greatly improved. These well record cards that have the most reliable data are selected to be translated for the computer.

Copies of the computer printed reports, as well as the well record cards, are on open file and available on request. Please indicate the county and townships desired when making any inquiry. The computer reports are divided into four separate types. Report A for each county denotes township, well number, owner, well location by latitude and longitude, and well use. Report B for each county lists depth of well, casing length, drill method, water level, yield, and drawdown. The topographic setting, major and minor aquifers, depth and type of surficial material are identified on Report C. Report P includes depths to water-bearing zones and driller's license number for each county. Each report type may be ordered separately. The original well record card contains all the information now on the computer plus a log of rock types. There are thirty well records on each page of the computer report. Three well record cards can be copied on a legal size sheet of paper. Copies are free for ten pages or less; any order over ten pages is 25¢ per page (including the first ten pages). Direct inquiries to Water Well Inventory, Bureau of Topographic and Geologic Survey, 914 Executive House, Harrisburg, PA 17101.

The latest inventory of water well data available for the respective counties is given below.

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[1] Dept. of Environmental Resources

County	Number of Sheets	Number of Wells
Adams	40	285
Allegheny	32	204
Armstrong	36	270
Beaver	40	281
Bedford	200	1499
Berks	296	2214
Blair	80	585
Bradford	104	778
Bucks	573	4299
Butler	100	750
Cambria	116	873
Cameron	12	77
Carbon	104	766
Centre	36	267
Chester	527	3957
Clarion	12	69
Clearfield	12	59
Clinton	34	254
Columbia	40	280
Crawford	166	1240
Cumberland	180	1346
Dauphin	168	1263
Delaware	12	77
Elk	8	41
Erie	176	1323
Fayette	12	90
Forest	16	113
Franklin	92	646
Fulton	20	156
Greene	16	107
Huntingdon	16	95
Indiana	64	459
Jefferson	40	272
Juniata	44	307
Lackawanna	80	575
Lancaster	496	3706
Lawrence	40	279
Lebanon	216	1614
Lehigh	172	1265
Luzerne	76	560
Lycoming	80	599
McKean	16	89
Mercer	44	313
Mifflin	68	466
Monroe	316	2366
Montgomery	148	1087
Montour	24	165
Northampton	164	1230
Northumberland	56	414
Perry	64	466
Philadelphia	N/W	N/W
Pike	100	420
Potter	40	275
Schuylkill	94	706
Snyder	33	251
Somerset	56	412
Sullivan	32	217
Susquehanna	36	278
Tioga	20	140
Union	88	666
Venango	100	739
Warren	12	66
Washington	96	721
Wayne	40	285
Westmoreland	44	330
Wyoming	36	273
York	224	1680
	6685	47,380

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Northeast Section, Geological Society of America

ANNUAL MEETING

FEBRUARY 28 to March 2, 1979
HERSHEY, PENNSYLVANIA

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The Northeastern Section of The Geological Society of America will meet February 28 to March 3, 1979 (Wednesday through Saturday), at the Hershey Motor Lodge & Convention Center, Hershey, Pennsylvania, together with the Eastern Section of SEPM and the Northeastern Section of the Paleontological Society. The meeting is sponsored by the Pennsylvania Bureau of Topographic and Geologic Survey; the Department of Geology, Dickinson College; and the Department of Earth Sciences, Millersville State College.

Technical sessions will be held Thursday, Friday, and Saturday, March 1, 2, and 3. Some 1200 geologists are expected.

Six symposia have been scheduled: (1) Mineral Resources in the Northeastern U. S.; (2) Trace Elements and Health; (3) Geology of Pennsylvania and the New Geologic Map of Pennsylvania; (4) Geology of Underground Radioactive Waste Disposal; (5) A Sampling of Current Research by the U. S. Geological Survey in the Northeastern U. S.: A Symposium on the Occasion of the Centennial; (6) Adirondack Geology. This symposium will be followed by an evening discussion session.

A short course on remote sensing and geology, conducted by Richard Williams, U. S. Geological Survey, will be conducted on February 28.

There will also be a Friday evening session open to public participation concerned with the geologic hazards of karst and trace elements. In addition to a large exhibit area, there will be a science theater of new and previously released U. S. Geological Survey films.

Registration information will appear in the December issue of the magazine "Geology" issued by The Geological Society of America. Registration includes free beverages at a welcoming party Wednesday evening and a smoker Thursday evening, as well as luncheon Friday preceding the annual business meeting of the section.

(Middle) East meets West

Seeking to compare technical and administrative techniques, Dr. Eliahu Zohar, Director of the Israel Geological Survey in Jerusalem, paid a two-day visit to the Bureau of Topographic and Geologic Survey in mid-November. Having previously visited the U. S. Geological Survey, Dr. Zohar was particularly anxious to see how a state geological survey functions.

During the course of discussions, Dr. Zohar noted that geologic and mineral resource investigations hold a high priority with the Israeli government. Israel, with an area approximately one-seventh that of Pennsylvania, maintains a Geological Survey staff more than twice the size of the Pennsylvania Survey staff. Dr. Zohar stated that mineral resources mapping and development is considered extremely vital to the Israel economy. He noted also that engineering geology and environmental geology are quickly being recognized as important subjects in that land where so much construction is taking place and where natural hazards, such as earthquakes, abound. Israel has a growing awareness, also, for the need to protect natural environmental conditions as development takes place.

Dr. Zohar was extremely interested in the Pennsylvania Geological Survey's attention to environmental geology. He gave a great deal of attention and praise to our atlas on Environmental Geology of the Greater Harrisburg Area (EG 4). He was particularly enthused over Pennsylvania Survey's technique of identifying engineering and economic geology factors on our geologic maps by use of a three column legend, a Pennsylvania Geological Survey innovation.

Many of the scientific and technical procedures utilized by our geologists are apparently similar to those conducted by the Israel Geological Survey. In comparing administrative procedures with Pennsylvania Survey Director, Dr. Arthur Socolow, it was noted by Dr. Zohar that it is a small world—the Israel Geological Survey also has problems of budget, manpower, and even red tape.

These exchanges with foreign visitors have proved to be extremely enlightening and certainly, mutually beneficial. We are pleased to have such distinguished visitors come to Pennsylvania.

◆

Welleraspis (Trilobita) in the Conococheaque Formation of Southeast Pennsylvania

by Richard M. Busch[1]
Michael S. Fedosh[2]

A discovery of the ptychopariid trilobite *Welleraspis swartzi* (Tasch) allows us to assign some beds of the Conococheague Formation near Morgantown, PA to the Early Late Cambrian. Previous workers discussed age relationships of the Upper Cambrian Conococheague Formation of southeast Pennsylvania mostly in a sedimentological sense due to a lack of collectable fossils. Gray, *et. al.* (1958) subdivided the Conococheague Formation into five members. From oldest to youngest, these are the Buffalo Springs, Snitz Creek, Schaefferstown, Millbach, and Richland Members.

During spring and summer of 1977 we measured a succession of Millbach beds exposed on the northeast side of a road-cut east of Morgantown, PA beginning at 75°52′45″ west longitude and 40°08′

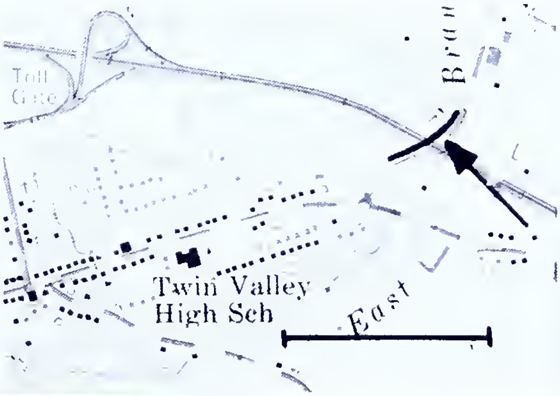

Figure 1: Portion of US GS Morgantown Quad. showing position of measured section. Arrow points to trilobite beds. North is at top of page; scale equals 0.5 kilometers.

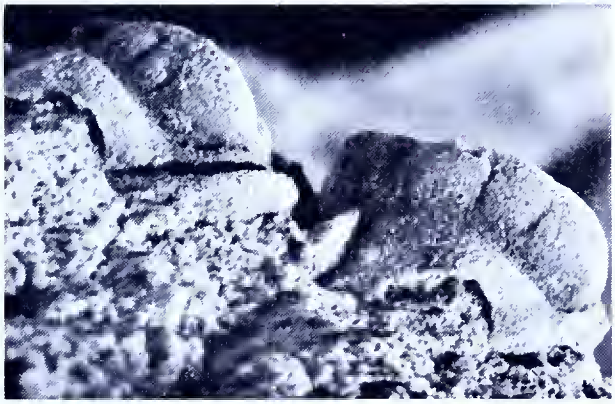

Figure 2: Two *Welleraspis swartzi* (Tasch) cranidia enlarged 8.47 times; North Museum catalogue number P-A-1144B.

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[1] North Museum
Franklin & Marshall College
Lancaster, PA 17604

[2] New Jersey Bureau of Geology
Box 1390
Trenton, NJ 08625

45″ north latitude (see Figure 1). There is much structural deformation due to microfaulting, faulting, folding, etc., which has no doubt resulted in some shortening or lengthening of the section. Subsequently, stratigraphic thicknesses should only be viewed in a relative sense. About 88 meters of the Millbach Member is exposed here, and due to the presence of abundant stromatolite beds, minor sand, and common oolites, the incomplete sections conforms lithologically to the upper portion of the Millbach as described by Gray, *et. al.* (1958).

Our trilobite specimens were collected in the interval of beds about 59.1 to 61.3 meters from the base of the measured sequence as indicated by the arrow in Figure 1. Specimens occur disarticulated and form scattered "hash beds" throughout the 2.2 meters of very thin to thin, interbedded, fine-grained limestone and dolomite. They appear to be dolomitized within the limestone beds and consequently are collectable only on weathered surfaces. Acid etching produced no specimens. Some ripple-marked horizons and poorly preserved ichnofossils (trace fossils) are also present.

Welleraspis has been reported from a variety of other Upper Cambrian rocks of North America and is a typical index fossil of the *Cedaria* zone. Although its stratigraphic range is sometimes variable, past workers such as Howell (1945) regard *Welleraspis* as being strictly *Cedaria* age. Consequently, we can now state that upper portions of the Millbach Member of southeast Pennsylvania are of Early Late Cambrian Age (early Dresbachian). *Welleraspis swartzi* (Tasch) also occurs in the lower 75.28 meters of the Warrior Formation of central Pennsylvania (Tasch, 1951). Some other occurrences of *Welleraspis* include the Limeport Member of the Allentown Formation in eastern Pennsylvania and New Jersey (Rasetti, 1954), the lower to middle Elbrook Formation of the central Appalachians (Wilson, 1952), and the Nolichucky Shale of the southern Appalachians (Tasch, 1951).

Most of the trilobite material we collected is deposited in the paleobiological collections at the North Museum of Franklin & Marshall College.

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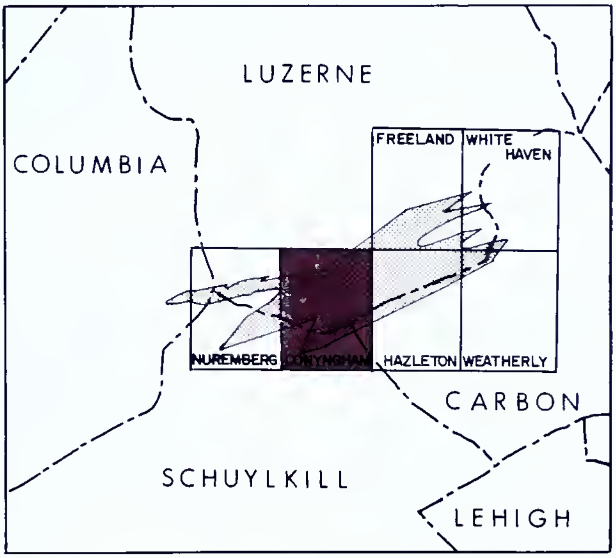
SURVEY ANNOUNCEMENTS

ANTHRACITE AREA STUDY

Recognizing that decisions and plans for the future development of the large remaining reserves of anthracite coal will require accurate data on the nature of the coal and related geologic structures, the Pennsylvania Geological Survey has initiated a detailed geologic mapping project near Hazleton. Covering a portion of the Eastern Middle Anthracite Coal Field, specifically the Conyngham Quadrangle, the area includes parts of Schuylkill and Luzerne counties. This is the first stage of a planned mapping program which will provide the basic information necessary to evaluate the mineral resources, define the ground-water conditions, and plan for proper environmental protection during and after mining.

There has been a growing awareness of the value of the large reserves of anthracite coal in northeastern Pennsylvania, particularly in view of the low sulfur content of the coal and its proximity to large energy consumers of the Northeast. Electric power generation and industrial plants are the primary indicated anthracite uses of the future.

The geologic mapping in the Conyngham Quadrangle will be carried out by staff geologist Henry W. Schasse. It is anticipated that the mapping of this quadrangle and the resulting report and map will be completed and available by 1980.



MIDDLE DEVONIAN STRATIGRAPHY OF CENTRAL PENNSYLVANIA

The Middle Devonian stratigraphy of central Pennsylvania has been refined and interpreted in the Pennsylvania Geological Survey's new report, *Middle Devonian Stratigraphy in Central Pennsylvania – a Revision.* Co-authored by Rodger Faill, Donald Hoskins and Richard Wells, the report includes a text and one plate. Type sections of two new members are included.

The new report resolves some of the stratigraphic complexities of the region and should be particularly helpful to professional geologists in understanding rocks of this age.

General Geology Report G 70 is available for $2.25 (plus 6% tax for Pa. Residents) from the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125.

DUBOIS AREA GEOLOGIC REPORT

A comprehensive new report on the geology and mineral resources of the DuBois area (western Clearfield County and eastern Jefferson County) has been published by the Pennsylvania Geological Survey. Authored by Albert D. Glover and William A. Bragonier, the 130-page report is accompanied by a full-color geologic map and by separate maps and plates for each of the major coal seams in the area. Calculations of coal reserves are presented, as well as data on other potential mineral resources. The engineering and groundwater characteristics of each geologic formation are defined on the map and in the text.

Five major bituminous coal seams in the mapped area represent the most important mineral resource; remaining in-place coal totals 375 million short tons in beds over 28 inches thick. Clay shale, sandstone, sand and gravel, limestone, and natural gas are other important resources.

This report provides a basic geologic inventory requisition toward land use planning, efficient mineral resource development, and sound land rehabilitation design. It should be of extensive interest and use to local officials, coal developers, engineers, conservationists, and the residents of the DuBois region.

Atlas 64, "Geology and Mineral Resources of the Hazen, Falls Creek, Reynoldsville, and DuBois Quadrangles," is available for $21.55 (plus 6% tax for Pennsylvania residents) from the State Book Store, P. O. Box 1365, Harrisburg, PA 17125.

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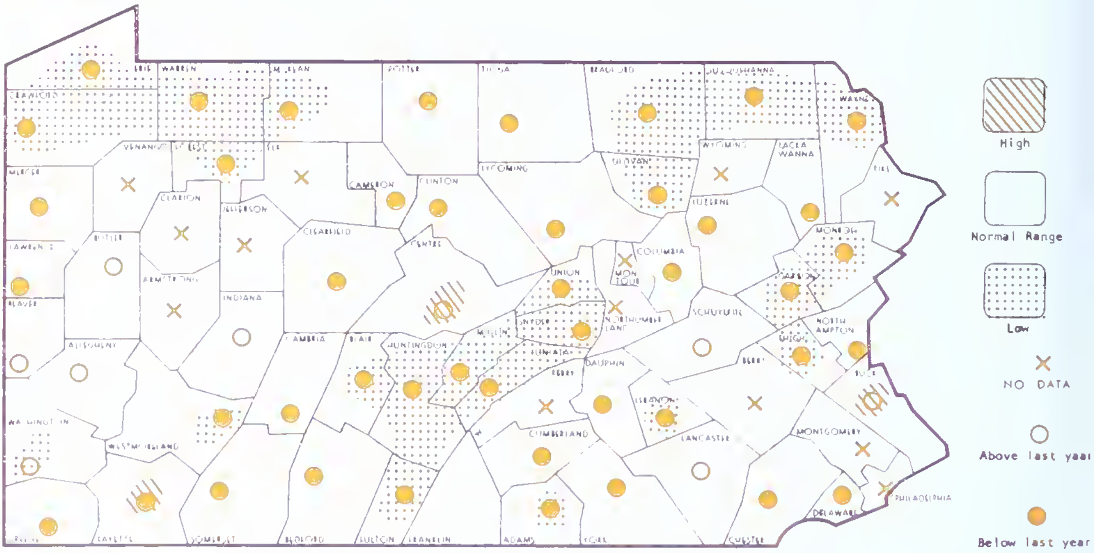

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